Railway Signaling & Communications

FEBRUARY 1966

DTA
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Because of increased demands on the lines, this cable was replaced by a Kerite cable of a larger conductor size.

In view of its perfect condition, and taking inflation into account, we figure that the old cable is now worth at least twice its original price. We will accept bids from all interested parties for a limited time only. For sentimental reasons, we would just as soon keep the cable ourselves as a souvenir of faithful service. The Kerite Company, 30 Church Street, New York, N. Y. 10007.

Simmons-Boardman
TIME-SAVER
Publication

HERE'S GRAPHIC PROOF OF

RACO SURGE PROTECTION

UNRETOUCHED PHOTOS show RACO's ability to provide positive protection from high voltage surges man-made or natural!
(and only RACO has them)

RACO "CLEARVIEW" ARRESTOR

Ref. 485-28

BEFORE SURGE

AFTER SURGE

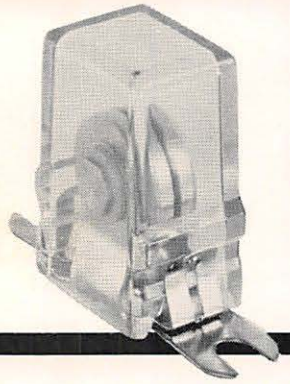
The "Clearview" Arrestor on the right (along with eight other units) was in service protecting the signal control lines of one of our northeastern railroads*. A transmission line at 18000V AC fell across the signal lines. The transmission line circuit breaks required 1.89 seconds to cut out.

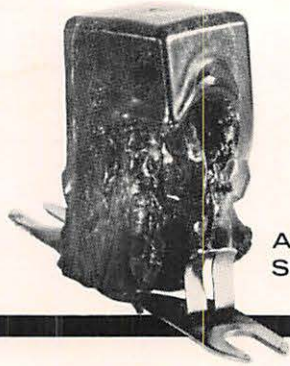
Damage to protected Signal Equipment – NONE • Grounds on Signal Controls – NONE

RACO HEAVY DUTY EQUALIZER

Ref. 700-1

BEFORE SURGE





AFTER SURGE

The EQUALIZER on the right was in shunt connection on a track circuit of one of our western railroads* on which was superimposed an electronic computer used in connection with control of grade crossing protection. A 48000V AC transmission line fell across the rails.

Damage to protected Signal and Electronic Equipment – NONE

*Names on request.

Contact the RACO GROUP office nearest you for complete details

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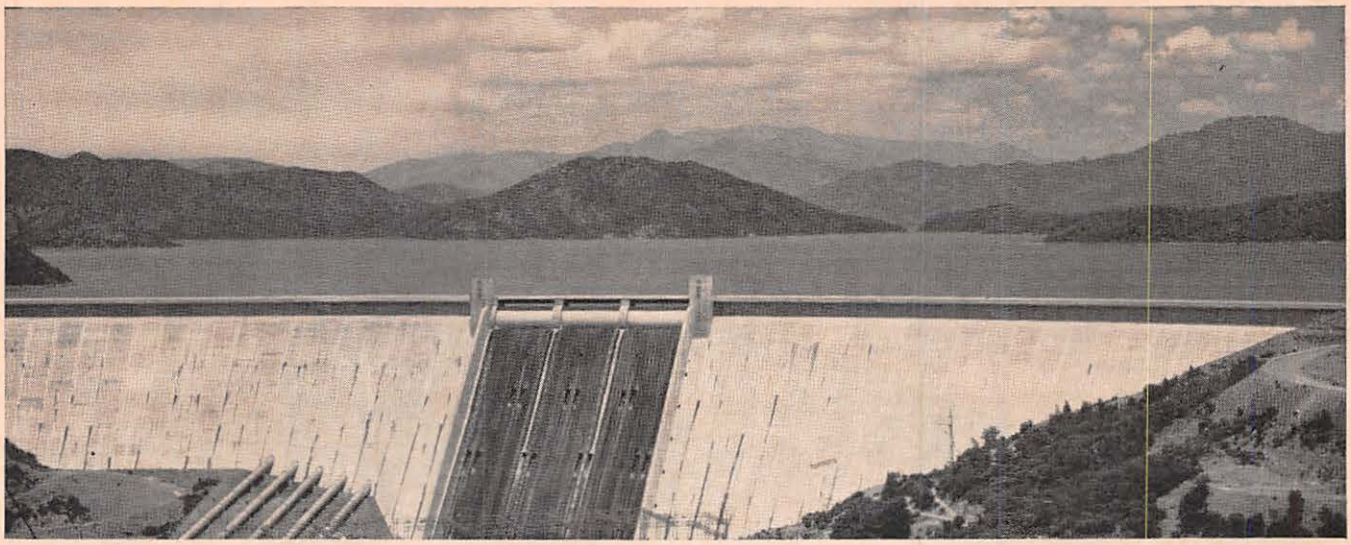

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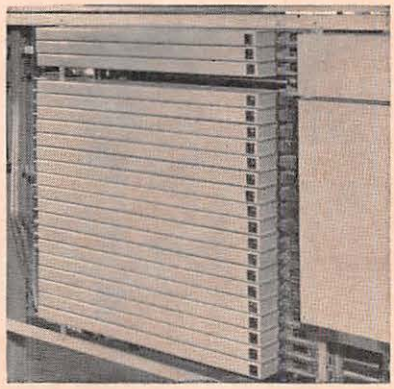

STROMBERG-CARLSON
A Subsidiary of General Dynamics
Circle 53 on reader service card

February 1966
Vol. 59 No. 2

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EDITOR'S CORNER

Call for Papers

To make this year's Communication and Signal Section, AAR, annual meeting a success, good papers must be presented. A call for such papers has gone out to railroads and railway suppliers. But to be sure that no one is missed who might have something to contribute, I add my voice to that of Secretary George McCann. The arrangements subcommittee desires to have papers covering . . . "new or unique installations and routines developed to solve modern communication and signal problems or advance the state of the art."

I am sure there are enough interesting subjects worthy of in-depth treatment which can be presented in 30 minutes to a signal and communications oriented audience. Here are some suggestions for papers: digital controls for automatic classification yards; communications and automatic car identification; planning and implementing a management information system; the role of the computer in signaling and communications; graduate electrical engineers—feast or famine in S&C; systems approach to signaling and/or communications; employee training—necessary evil or blessed event?

The time for action is now if authors are to have time to prepare their papers. Send a brief statement or digest of the paper, with the author's name, title and company affiliation to the Secretary, C&S Section, AAR, 59 East Van Buren St., Chicago, Ill., 60605. Send your paper digests as soon as possible. It's not too early to begin action on these papers. The C&S annual meeting is Sept. 20-22 in Washington, D.C. It can be the best meeting ever if everyone pitches in and works to prepare some fine presentations. So let's flood Secretary George McCann with those paper digests?

Bob McKnight

P.S. Our March issue will cover the ICC's Division 3 report on the Signal RS&I changes.

Copper Oxide Cells

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M-500

M-1000

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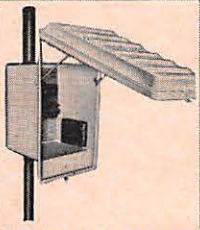
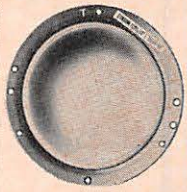

No. 5000 Fiberglass Telephone Box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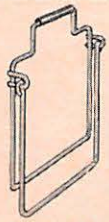
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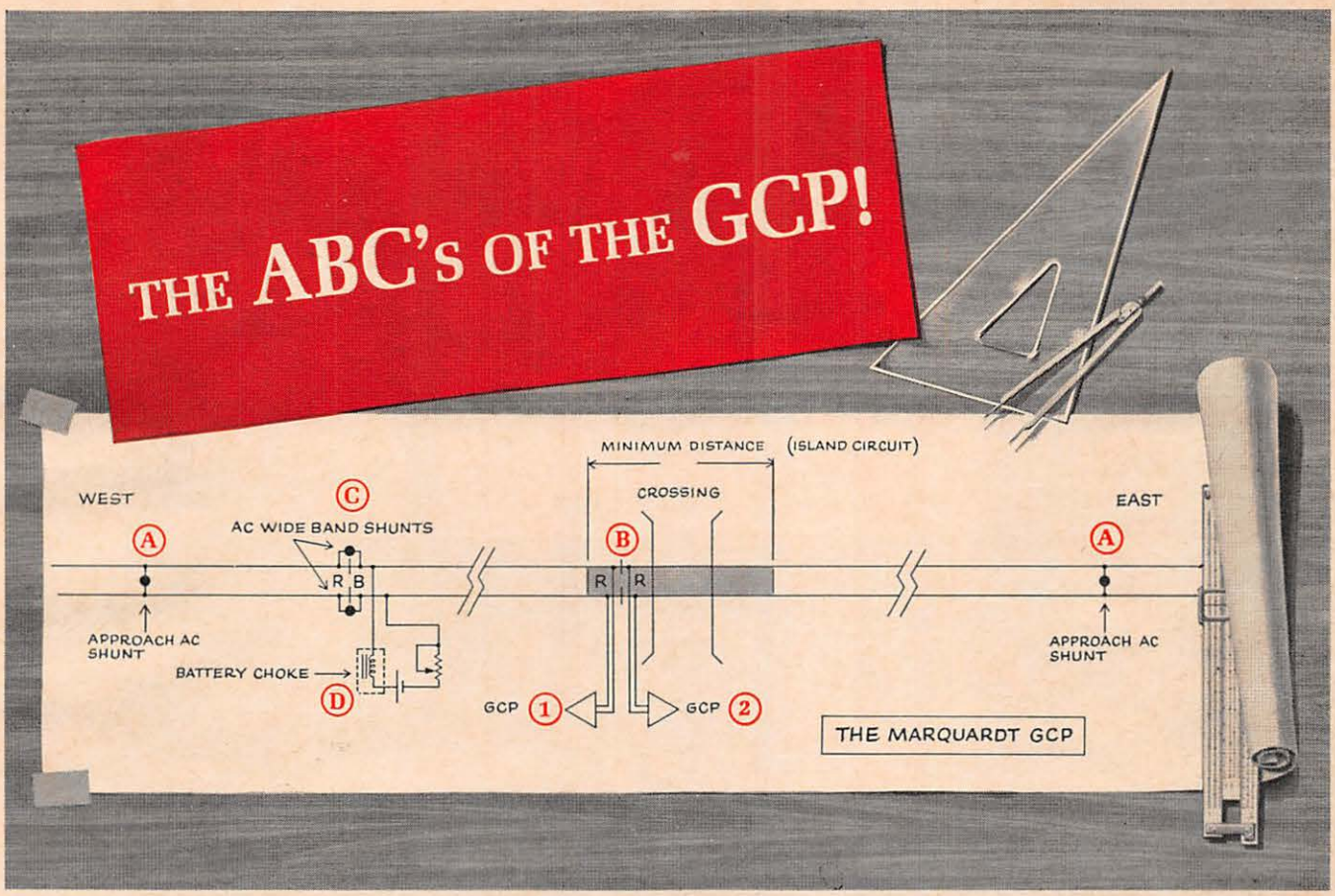
McGRAW EDISON

Circle 54 on reader service card



This is how the Marquardt Grade Crossing Predictor (GCP) provides fail-safe crossing protection and reduces highway traffic delays.

The Marquardt GCP is a solid state analog control system, designed to compute speed and position of an approaching train, predict its arrival at the crossing, and activate the warning system.

The train is approaching the crossing from the west. The Grade Crossing Predictor number (1) senses an impedance corresponding to the distance from the crossing to (A) the approach shunt. As the train enters the GCP circuit, it acts as a "moving" shunt, reducing the impedance as it approaches the crossing.

Since each GCP is constantly measuring the impedance level as well as the rate of change, it can predict the train's arrival at the crossing and activate the protection system at the pre-selected warning time. Uniform warning time on constant speed trains is thus provided regardless of the train speed.

Should the train stop in the approach, the GCP no longer senses a change in impedance. An already-activated warning system will be cleared within seconds. If the warning system was not activated, of course, nothing happens. As the train resumes its approach to the crossing, the GCP again senses the impedance change and immediately activates the warning system. The warning devices will be deactivated as the last trucks clear the minimum distance (island circuit). If the train reverses direction after having gone through the crossing, Grade Crossing Predictor number (2) takes over. Highway traffic is resumed with minimum delay.

BASIC FEATURES OF THE GCP SYSTEM

■ *Note that only two insulated joints (B) are actually required for GCP operation. These serve to isolate one approach from the other, establishing a defined circuit from the joints to the approach shunt (A).* ■ *Where other insulated joints exist in the GCP approach circuit, AC wide band shunts (C) are used to bypass these joints, thus providing a complete circuit down one rail, through the approach shunt, and back the other rail to the GCP. The shunts are 80,000 microfarad capacitors which block the DC signal. These are encapsulated and waterproofed for burial below the frost line alongside the track.*

■ *Where a battery is connected to the track, a battery choke (D) is installed in series with one of the battery leads. This prevents the AC signal from shorting through the battery. The choke has a high impedance to AC, and because of its low resistance (0.25 ohms), it has little effect on the DC circuit.*

■ *The approach AC shunts (A), connected from rail to rail, complete the GCP circuit. They are located at a distance from the crossing corresponding to maximum train speed and required warning time.*

■ *Built-in self-check system insures fail-safe GCP operation. The system simulates an approaching high speed train every 4.5 seconds, even when a train is on the track. Should a malfunction occur, the warning system is immediately activated.*

Write or call your Marquardt representative today. Ask him to show you how the Grade Crossing Predictor can meet your specific crossing protection requirements.

THE Marquardt CORPORATION

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310 S. Michigan Blvd., Chicago, Ill. Phone: 312-922-1156

Circle 55 on reader service card

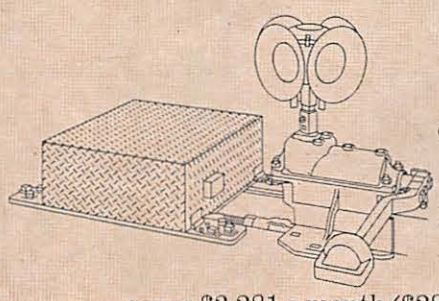
CONFIDENTIAL

Case history ...

Application: N.Y. Central, White Plains yard 8 hydraulic switch machines with #22 stands.

Submitted by: W. Kilrea

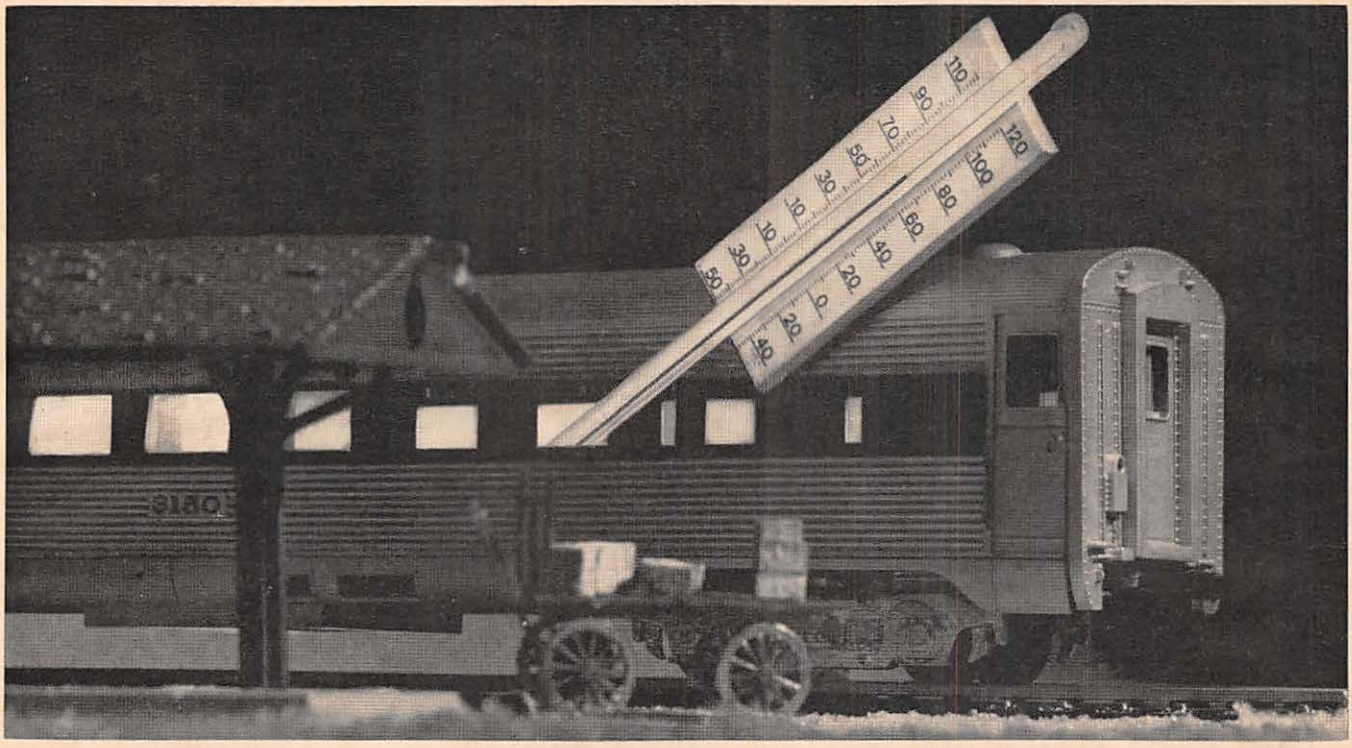
Confidentially, they're saving $2,281 a month.



New York Central used to spend $27,375 a year to operate three switches to the car wash and five to the Diesel refueling area, in their White Plains yard. They installed eight of our Hydraulic Switch Machines with #22 Switch Stands. What happened? Payoff reached in just eleven months. After that, the Central saves $2,281 a month ($285 per machine). Tell your Brake Shoe man you want to see the many features of this machine for yourself. Or contact:

Abex
AMERICAN BRAKE SHOE

Railroad Products Division, 530 FIFTH AVENUE, NEW YORK, NEW YORK 10036



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Circle 56 on reader service card

Circle 57 on reader service card

NEWS BRIEFS

• BALTIMORE & OHIO has ordered type J traffic control equipment from General Railway Signal Co., to control the movement of trains over a weighing station at Warwick, Ohio where the control machine will be located.

• CHESAPEAKE & OHIO has received ICC approval to make modifications to an existing traffic control system on two tracks between Minford and Robbins, Ohio, 15 miles. Also, C&O received approval to install a traffic control system replacing existing automatic block-signal system with remotely controlled switches and associated signals, on two tracks between Robbins, and "RA" Jct., Ohio, about 15 miles.

• CHICAGO TRANSIT AUTHORITY has begun work on a new on-board electronic train control system for the Lake street line. The system will be completed this year, and 70 rapid transit cars will be equipped. The equipment has been designed and built by General Railway Signal Co. High frequency track circuits will carry information and instructions directly to the train operator. The system eliminates wayside signals and insulated joints in the track. In addition to the usual Proceed and Stop signals, the maximum safe operating speeds governed by conditions ahead will be continuously displayed by cab signals. Should the operator exceed this speed or fail to reduce speed when instructed, the automatic control system takes over and brings the train to a complete stop.

• FLORIDA EAST COAST has received ICC approval to install a traffic control system replacing existing automatic block signaling between White City and Lake Park, Fla., 42.2 miles. Certain portions of second main track will be removed and other portions will be converted to sidings.

• GULF, MOBILE & OHIO has ordered type J centralized traffic control equipment from General Railway Signal Co., to further expand their Wann to Bloomington, Ill. installation north to Pontiac, 34.7 miles. The existing Traffic Master pushbutton control center at Bloomington, will be enlarged to accommodate the added controls.

• NORFOLK & WESTERN'S new $13.3 million yard at Bellevue, Ohio is about 25% complete. In addition to automatic switching and automatic retarder controls, the digital computer will account for cars in the class yard. These class yard controls are being furnished by Union Switch & Signal division of WABCO. This new automatic yard will have complete communications systems including loudspeakers, telephones and two-way radio.

• SOUTHERN has placed a $1.3 million contract with Radiation, Inc., for the purchase of several Locotrol systems to provide automatic control of locomotives in freight trains. Remote units of the system are located in a car toward the rear of a train and can be used to control several diesel-electric units at one time. VHF radio provides the communications link between the control units and the locomotives.

Railroad Personnel

• CANADIAN NATIONAL TELECOMMUNICATIONS: **Harold J. Clarke,** assistant general manager of telecommunications, appointed general manager at Toronto, Ont.,

(Please turn to page 46)

This Was News 50 and 25 Years Ago

The Signal Engineer, February 1916. Pennsylvania has completed a five track bridge over the Schuylkill river in Philadelphia, Pa. Formerly this traffic was controlled by two mechanical interlocking plants. A 40-lever machine governed the west end and an 8-lever machine on the east end governed all movements there. The signals were electropneumatic controlled from the mechanical machines. Under the new layout, these two interlockings are replaced by one electropneumatic, 55-lever interlocking machine. Style B-3 electric switches, 110-volt DC were used. The high signals and the three-position dwarf signals were style T-2, 110-volt DC.—Delaware & Hudson has recently put in service a section of 23 miles of automatic block signals on a single track line between Plattsburgh and Rouses Point, N.Y. The traffic averages 14 freight and 6 passenger trains daily. At passing sidings two-arm bracket masts are used; one signal arm governing movements from the sidings to the main line.

Railway Signaling, February 1941. St. Louis-San Francisco has installed an all-relay, electric interlocking plant at Sapulpa, Okla., including 7 operative home signals and 4 electric switch machines for operating the crossovers. The interlocking control machine is equipped with miniature levers without mechanical locking between levers or lever locks. The locking is accomplished by interconnection of circuits. The old #10 crossovers were removed. Using new 112 lb rail, two #20 crossovers wtih 30 ft points were installed at two locations in order to permit diverging train movements to be made at higher speeds of up to 35 mph. Automatic block signaling will be extended on 45 miles of single track from Sapulpa southwest to Henryetta, Okla., on the route to Sherman, Tex.—Louisville & Nashville has reconstructed and enlarged its northbound classification yards at DeCoursey, Ky. Power switches, car retarders, communication systems, flood lighting, snow melters, and special office machines were installed to improve the classification operations, and reduce the operating expenses. Every 24 hours, 2400 cars are classified. The switches were hand operated, and the car riders were employed to bring the cars to a stop on the classification tracks. In the new yard, only one machine is required to control the retarders and power switches. **RS&C**

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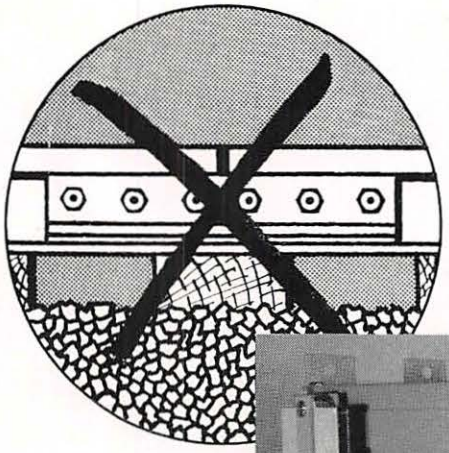
PAYS ITS WAY EVERY DAY

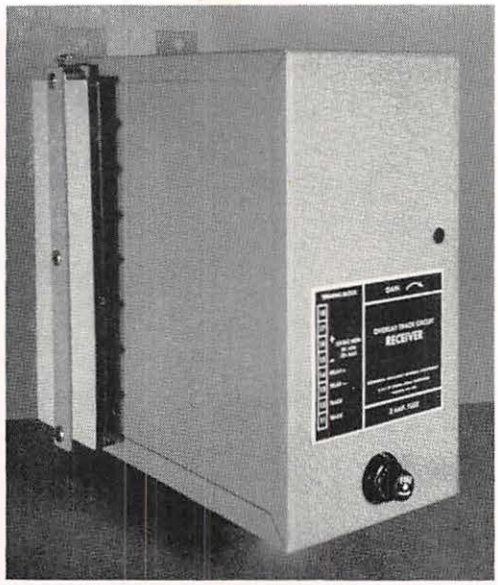
Count on Motorola 2-way portable radio to be ready for action where and when it's needed! In fair weather and foul . . . in emergencies, sure, but primarily as an everyday railroad communications tool that saves time and money. With the industry's *lightest* (36 oz.) portable you get both "talk and hear" in one compact package. Orders and answers come through loud and clear—in the noisiest locations. You can "mix and match" the radio with a flexible accessories group to meet every need—car inspection, classification, loading operations, construction and m/w uses. Fully transistorized for day-in, day-out reliability and pennies-a-day operating costs. Let your Motorola Railroad Representative show you a unit in action. Call or write: Motorola Communications & Electronics, Inc., Dept. ARW-608, 4935 W. Le Moyne Ave., Chicago, Illinois. A Subsidiary of Motorola Inc. (312) 379-6700.

MOTOROLA RAILROAD RADIO

Circle 75 on reader service card



How can the high costs of insulated joints be avoided at highway crossings ?



Easy— Modern, solid state electronic track circuits eliminate insulated joint installation and maintenance costs. GRS overlay electronic track circuits provide complete crossing protection control—for flashing lights or for gates—without cutting the rails.

Here's how— GRS overlay circuits superimpose directly on existing railway signaling track circuits—a-c, d-c, or coded. No interference with regular track circuits. Typical track circuit range is up to 4,000 feet each side of a crossing.

ADVANTAGES:

No joint installation costs.
No joint maintenance costs.
No cutting of continuous welded rail.
No delay to traffic during installation.
No need for extra instrument cases or for track circuit repeater equipment.

AN IMPORTANT PLUS—When you specify GRS, you get all your equipment from one source—not only overlay track circuits, but also flasher signals, relays, cases, etc.—everything you need, including experienced railway signaling systems engineering.

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NEW YORK, N.Y. 10017 CHICAGO, ILL. 60601 ST. LOUIS, MO. 63101 MONTREAL 2, P. Q.

GRS

3378

Circle 59 on reader service card

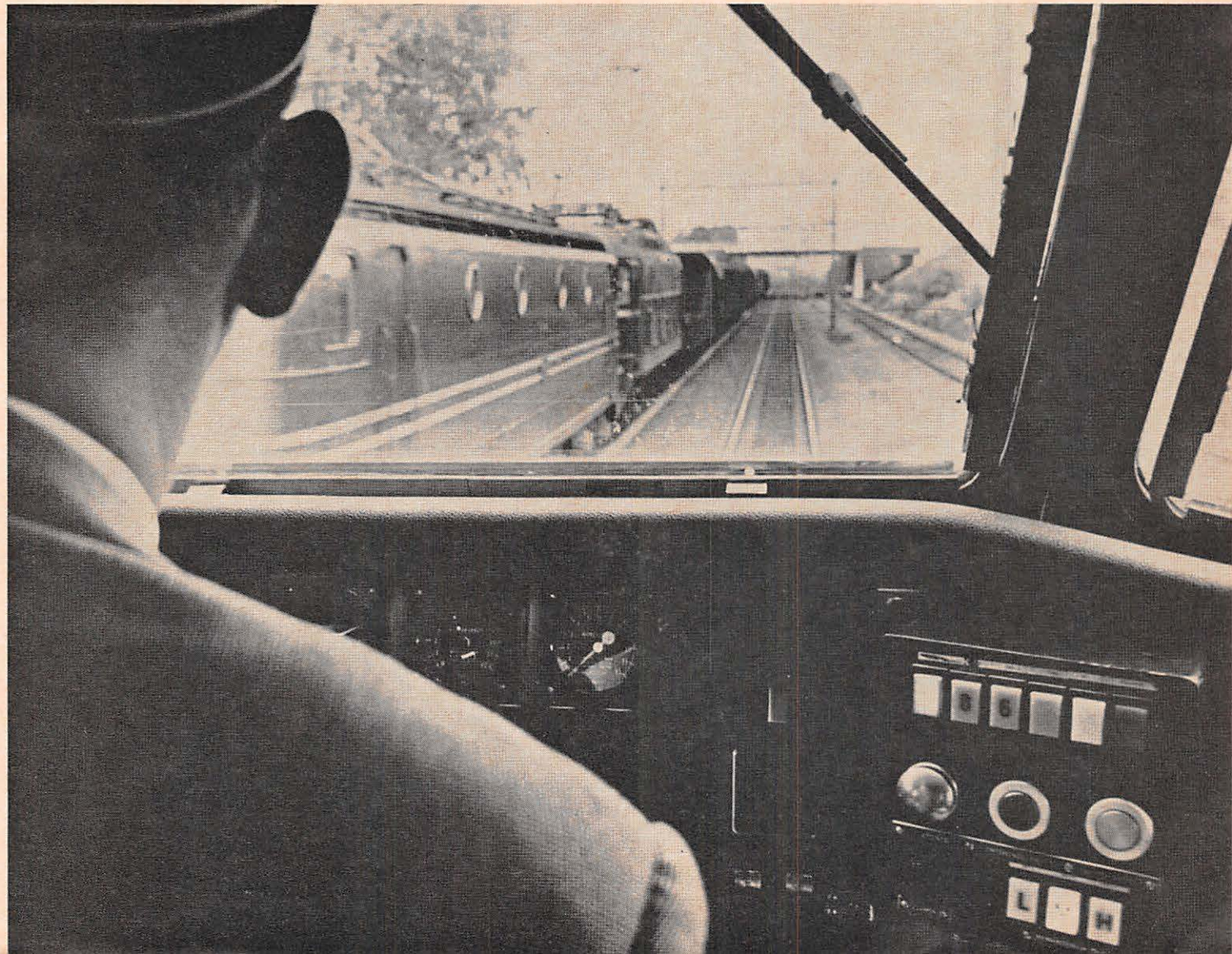
Netherland Rys installs ATC

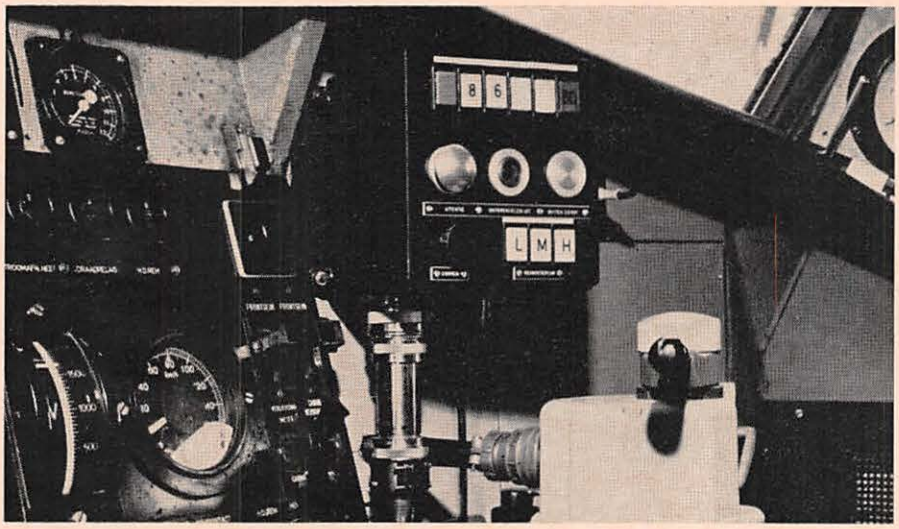
Netherland Railways have placed in service the first portion (28 mi) of a continuous inductive, automatic train control system with speed control and cab signals, on the electrified line (1500 DC) between Amersfoort and Amsterdam.

This is the first installation of continuous ATC on the continent of Europe. It provides maximum train protection, yet allows maximum flexibility in regular train operation, with four controlled speed levels. The system can be expanded to incorporate additional controlled speed levels if required.

Briefly, the ATC system ensures safety of train operation by maintaining constant surveillance of the engineer's responses—or lack of responses—to wayside conditions. It alerts him when there is a change in signal aspect, and penalizes him—with an automatic brake application—when he ignores a more restrictive signal aspect or operates overspeed.

The system continuously transmits information between the wayside and train as to block conditions ahead. This is done by means of a





Cab signal indicator shows speed (8 or 6, above) and braking rate, L, M, H.

coded current which is fed through the rails and inductively coupled to receivers mounted on locomotives and multiple-unit trains.

The train-carried and vital wayside equipment is being manufactured and supplied by the General Railway Signal Company through its affiliate company in Holland, Algemene Sein Industrie, N.V. ASI is designing the wayside circuits and supervising the installation of the train-carried equipment. In future, equipment will be supplied by Nederlandse Standard Electric under ASI's direction.

In Holland, all main tracks are equipped, or will be equipped when installing ATC, with automatic block signaling, employing single- and double-rail 50-cycle AC track circuits. Thus, a carrier frequency of 75 cycles was selected for ATC: (1) to prevent system interference from propulsion and stray currents present in the track, and (2) to permit the continued use of single-rail track circuits, particularly within large interlocking limits where double rail track circuits with impedance bonds could be avoided.

Information as to wayside conditions is continuously transmitted to the train by interrupting the carrier frequency at different code rates of between 120 and 220 pulses per minute. When a train enters a block, the wayside track equipment is energized (approach coded) and applies a special code rate to the track, each rate based upon the aspect displayed by the next signal in advance. A code rate of 120 pulses per minute indicates a maximum permissible speed of 75 mph; 180 pulses per minute, 50 mph; and 220 pulses per minute, 37.5 mph. A lack of code permits a maximum permissible speed of 25 mph, providing that the engineer continues to acknowledge a buzzer signal every 20 seconds.

A "two-phase" amplifier, which amplifies the voltage induced in the receiver, produces an output from the right-hand coil which is compared with the output of the left-hand coil. Only those signal voltages that are 180 deg out of phase can be valid, as the coded current that flows in one rail in one direction must flow in the other rail in the opposite direction.

A comparator checks the input signals from both receivers and produces an output only when both signals have the same code rate and are in the proper phase relationship. Moreover, the ratio of the amplitudes of both input signals must have a certain minimum value. Thus, a coded current that flows in one rail only as, for example, with single-rail track circuits, can not be accepted as a valid piece of information.

Electronic time rate decoders detect the code rate being received. The output of a decoder operates its associated relay to display the permitted speed in the cab signal.

An axle-driven generator produces an AC voltage with a frequency which is proportional to the actual train speed. Actual and controlled speeds are compared continuously and, as soon as the actual speed is higher than the controlled speed, an audible indication warns the engineer to brake within a few seconds or receive an emergency brake application.

The required braking rate is also displayed by the cab signal. Maximum braking distance permitted is the same for all trains and equal to a minimum signal spacing. When operating with a multiple-unit train at a speed higher than 65 mph, a "high" brake application is required; at speeds between 65 and 53 mph, a "medium" application; and below 53 mph, a "low" brake application. For diesel or electric locomotives, a "high" brake application is required when above 53 mph, and a "low" brake application below this speed. The applied braking rate is checked through brake handle contacts and a pneumatic differential switch.

If the engineer does not respond properly to a cab signal indication requiring a speed reduction with the required brake application, an electro-pneumatic valve in the brake system opens, causing an emergency brake application. Simultaneously, the propulsion power supply is cut off. When braking to a controlled speed limit—for example, 50 mph—the system would indicate release of the brakes when a speed of 55 mph is reached. This feature—which compensates for the release time of the brake system—provides less delay and more efficient train operation. When the engineer responds correctly and the speed is sufficiently reduced, a bell sounds to indicate that the brakes can be released.

The ATC system is self-checking and organized in such a way that failures will result always in favor of safety.

The cab signal displays the following aspects and braking rates. The braking aspects are also marked on the brake handle.

When operating under a yellow aspect (25 mph), the engineer must acknowledge a buzzer signal every 20 seconds, and do it within three seconds.

Aspect	Indication
Green	—maximum permissible speed—75 mph
Yellow 8	—maximum permissible speed—50 mph
Yellow 6	—maximum permissible speed—37.5 mph
Yellow	—maximum permissible speed—25 mph
BD (in blue)	—non-signaled territory
L	—low braking rate
M	—medium braking rate
H	—high braking rate

When entering and leaving ATC territory, the train-carried equipment is switched on or off automatically, but to achieve greater safety, the engineer must also acknowledge by operating the prepost-acknowledgement button to suppress a penalty brake operation. When operating in non-cab signal territory, the non-signal indication light (BD) illuminates.

The audible indications include:

1) A single stroke bell, which sounds for each change in signal aspect and sounds intermittently when entering non-cab signaling territories.

2) A continuous bell, which sounds for an overspeed indication and sounds with three short rings when the release speed is reached.

3) A buzzer, which sounds for recurrent acknowledgement when operating on a yellow signal aspect.

Failures of the engineer will always result in an emergency brake application which brings the train to a full stop. Thus, with the introduction of ATC, the serious consequences of human failure are reduced.

The installation of ATC on all main lines is an extensive endeavor. Nevertheless, the Netherlands Railway have scheduled completion of the project before 1975. It is anticipated that by 1 January, 1969, all traction vehicles and about 625 mi of track will be equipped with ATC. By 1 January, 1971, all tracks on which trains run at a speed in excess of 62.5 mph will be equipped, and by 1975 all tracks for passenger trains, totalling about 1550 mi (out of a possible 1860 mi), will be equipped.

In adopting its current program, Netherland Railways has the benefit of the considerable body of knowledge already built up in the field of automatic train control. The Office of Research and Experiment of the International Union of Railways, in Utrecht, has been studying the subject for some years. Netherland Railways has been testing ATC equipment of various types since 1953, and in 1958 began trials of different systems on its 18 mi Amsterdam-Hilversum line. In 1962, new urgency was brought to the subject by a serious accident near Harmelen; in the following year Netherland Railways selected the GRS-ASI system. **RS&C**

Controls and the Computer: 2

Computer study aids transit signaling

By Simon Reich

The people of the San Francisco Bay Area recently approved a $792 million bond issue to build a rail rapid transit network to serve San Francisco, Oakland, Richmond, Concord and Fremont, Calif.

The Bay Area Rapid Transit District, developer of this 75-route mile rapid transit system, contracted with the consulting engineering firm of Parsons Brinckerhoff-Tudor-Bechtel, a joint venture, to design and construct a system capable of moving the number of passengers who will desire transportation from San Francisco to the suburbs. Each passenger will have a seat in a comfortably air conditioned, fast moving car. Operating speeds will be such that travel time will be less than on competing freeways, and fares will be less than the out-of-the-pocket cost of driving to work. Parsons Brinckerhoff-Tudor-Bechtel, in turn, requested the railroad supply industry to develop new concepts of design and engineering to realize these objectives.

One of the areas of intense interest was the train control system. This system will be responsible for operating the trains safely at speeds up to 80 mph, bringing them to stops in stations, and maintaining the correct number of trains on the system for handling the passenger load.

One of the important portions of the train control system is the train protection system. The function of the train protection system is to guarantee that trains operate safely. This includes protection against rear-end and head-end collisions, enforcement of speed limits, and protection of junctions for safe train movements. The train protection system must perform these functions in such a way that system capacity is not reduced significantly. To determine the type of train protection system to be used, a computer study of the various types of train protection systems was undertaken at the General Railway Signal Company.

Two general types of train protection systems present themselves: the moving block or ideal system, and the fixed block or traditional system. These definitions refer to the method used to prevent rear end collisions between trains following one another.

The moving block system is defined as a system in which each train always knows the exact position of the rear end of the train ahead of it and governs its operation accordingly. The speed of a following train is controlled so that it is always equal to, or less than, the speed from which it may safely stop at normal deceleration rates before colliding with the rear of a leading train. This ideal system, it would appear, would maximize the capacity of the transit system.

The fixed block system is defined as a system in which the railroad is physically and permanently divided into a number of fixed blocks. A block is a length of track between two fixed points. Each block may have one of two possible states: occupied if any portion of a train is within the block limits and unoccupied if there is no portion of any train within the block limits. Each block is of such length that a train

Mr. Reich is Leader, Rapid Transit Group, General Railway Signal Co.

entering the block at maximum attainable speed will be able to stop before leaving the block. Combining these two characteristics of the block into an operating system, safe protection against rear end collisions can be provided if trains entering an unoccupied block behind an occupied block are signaled to stop, whereas trains entering an unoccupied block behind another unoccupied block may proceed at maximum authorized speed.

The difficulty with any train protection system is that it inherently tends to impede the movement of trains following one another on the rail transit line. Thus, a study of the characteristics of different types of train protection systems to determine their impedance under different traffic conditions would be useful to determine the requirements of a satisfactory system and to establish the requisites for system hardware. Since rapid transit operation involving many trains interacting with one another is a very complex system, it was decided that a computer model of the system would be required for a thorough analysis. A study was undertaken of train protection systems with the ultimate purpose of devising a system suitable for application to rapid transit lines such as the BARTD system.

This project proceeded by:

(1) Devising a model for the moving block train protection system and running the model under various conditions to determine the characteristics of this type of train protection system.

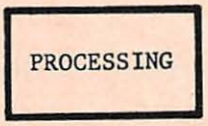
(2) Devising a comparable model for the fixed block train protection system. This model would be used to evaluate block locations as well as to evaluate the general characteristics of a fixed block train protection system.

(3) Devising and investigating various methods for computing the location of block points for a fixed block system. These block points were then used in the fixed block model to determine the operating characteristics of the various block locating methods.

A section of the Bay Area Rapid Transit District System between Daly City and Fremont was chosen as the location of the study. This section is about 38.6 miles long and includes a section of railroad in the downtown area in which the stations are close together, as well as a section in suburban territory, in which the stations are far apart. Grades and curves were taken from the preliminary route locations established by the consulting engineering firm. Car operating characteristics were assumed to be those of a projected rapid transit vehicle for the BARTD system.

PROGRAM FLOWCHART SYMBOLS

THE BEGINNING, END OR A POINT OF INTERRUPTION IN A PROGRAM.



A GROUP OF PROGRAM INSTRUCTIONS WHICH PERFORM A PROCESSING FUNCTION OF THE PROGRAM.

THE DECISION FUNCTION USED TO DOCUMENT POINTS IN THE PROGRAM WHERE A BRANCH TO ALTERNATE PATHS IS POSSIBLE BASED UPON VARIABLE CONDITIONS.

The results of the investigation have disclosed that:

(1) The moving block train protection system has a very well defined minimum headway. For the section of rapid transit line investigated, and under the assumed conditions, it was found to be 55 seconds.

(2) At the minimum headway, the average speed, including station stops, is about 42 mph.

(3) The characteristics of this train protection system do not permit the minimum headway to be attained immediately. Instead, it is approached slowly. The second train can follow the first with a headway of 88 seconds; the sixth can follow the fifth with a headway of about 77 seconds; and the 9th can follow the 8th with a headway of about 72 seconds. Headway is defined as the time between the departure of the $(n+1)$th train and the nth train from a station. It takes about 50 or 60 trains before the 55 second headway is finally attained. These headways are measured at the last station. The values are not substantially different than the headways measured at any other station but the first. Thus, this type of system will require a build up time to reach the desired headway and will not provide instantaneous recovery from delays caused by such conditions such as breakdowns.

(4) The fixed block train protection system also has a very well defined minimum headway. This has been determined to be 63 seconds, if speed limits are enforced in each block according to a precomputed preset pattern, or 66 seconds headway, if no speed limits are enforced.

(5) The average velocity, including station stops, for a fixed block system with speed limits enforced is about 47 mph.

(6) The characteristics of a fixed block system will permit the minimum headway to be attained between the very first pair of trains operated and to be maintained throughout the course of operation. Thus, the characteristics of a fixed block system permit step functions of headway changes and provide rapid recovery from delays caused by equipment breakdowns.

The above results do not necessarily indicate the actual results that will be attained by running trains using either type of system. Instead, they only reflect the results of running the model. The models included certain simplifying assumptions. However, since both the fixed block and the variable block models were constructed with identical assumptions and since analysis indicates that these assumptions and the resulting inaccuracies do not weigh the results toward either system, the results of the two models are directly comparable, even though their absolute values are not exact.

To understand more completely

the preceding results, the logical details of the moving block and fixed block models are described below.

For both models, train performance is calculated on a second by second basis. The performance of the train at the end of each second is predicted on the basis of conditions which a train encounters at the beginning of the second. Thus, from the train's position and velocity at the beginning of a second, a new position and velocity is assigned for the end of the second. This new value of velocity and position is used for the calculation of train performance during the next second. This system, using increments of one second, was chosen to provide for accurate and simple calculations of velocity, accelerations, and distances, assuming uniform linear motion.

Each train is run through the system in turn. The operation of the first train permits those factors which will influence the operation of the second train to be recorded. Also recorded are the departure and arrival times at each station to permit the calculations of headway.

After the first train finishes its trip, the second train is run from the first station taking into account the first train's position as if the first train were running in front of it. This process is continued until the last train is run.

The models can be broken down into five major subprograms:

(1) Station stop, output recording, and overall program control.

(2) Determining acceleration due to grades and curves.

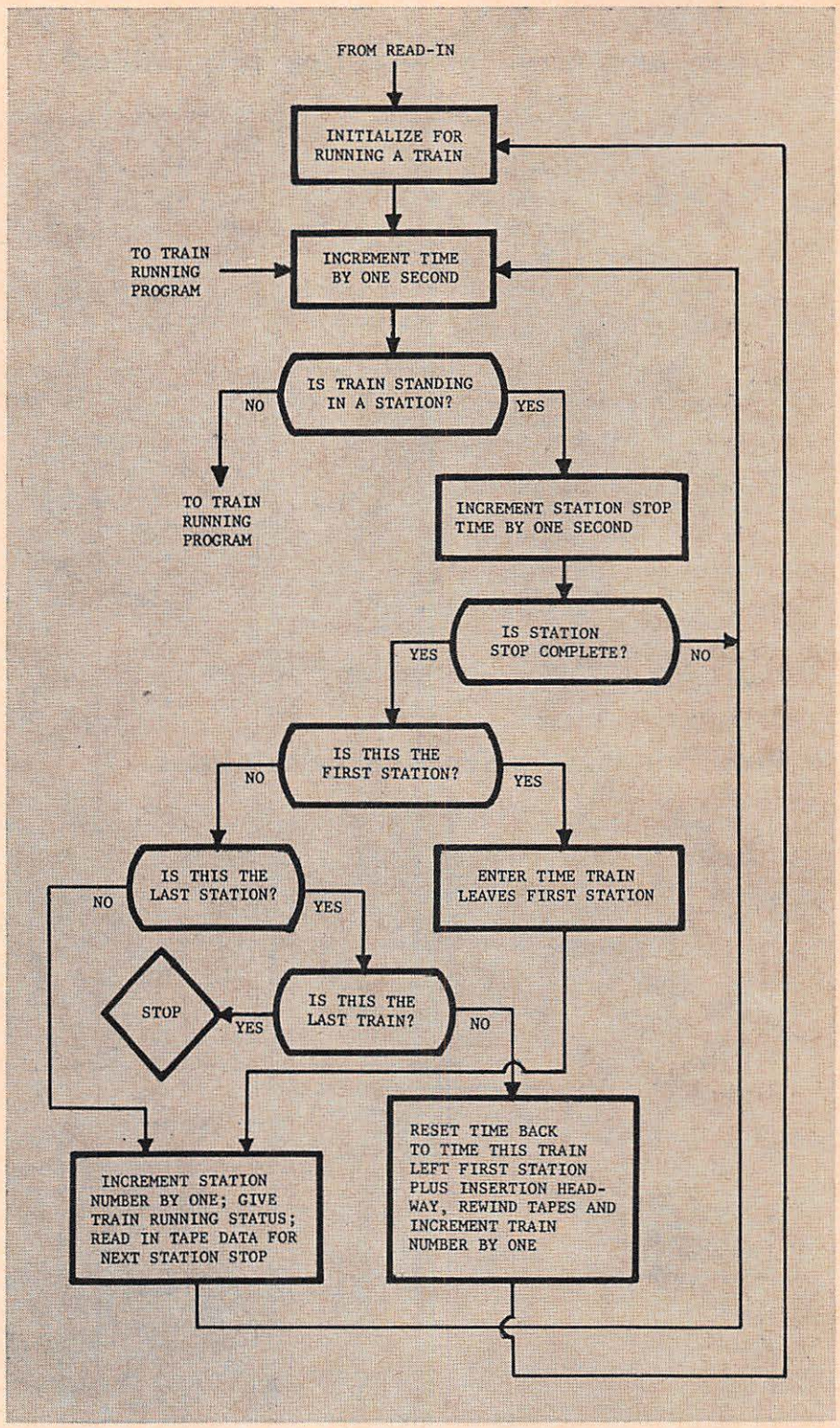
(3) Determining acceleration due to motoring.*

(4) Making a station stop.

(5) Enforcing train protection.

The first portion of the program controls the general operation of the model. It introduces the first train into the system and causes it to run from the first station to the last station. When the train completes its station stop in the last station, it is removed from the system. The second train is then introduced into the system and repeats this procedure at a certain interval after the first train left the first station. This interval is called the insertion headway and is a parameter which can be varied to investigate the characteristics of the block locations or system being tested. Finally, when the last train arrives at the last station and has completed its station stop, the computation is stopped. A flow chart of this portion of the program is shown in Figure 1.

1: Program for general operation of model.


FROM READ-IN
INITIALIZE FOR RUNNING A TRAIN
TO TRAIN RUNNING PROGRAM
INCREMENT TIME BY ONE SECOND
IS TRAIN STANDING IN A STATION?
NO
YES
TO TRAIN RUNNING PROGRAM
INCREMENT STATION STOP TIME BY ONE SECOND
IS STATION STOP COMPLETE?
YES
NO
IS THIS THE FIRST STATION?
NO
YES
IS THIS THE LAST STATION?
NO
YES
ENTER TIME TRAIN LEAVES FIRST STATION
STOP
IS THIS THE LAST TRAIN?
YES
NO
INCREMENT STATION NUMBER BY ONE; GIVE TRAIN RUNNING STATUS; READ IN TAPE DATA FOR NEXT STATION STOP
RESET TIME BACK TO TIME THIS TRAIN LEFT FIRST STATION PLUS INSERTION HEADWAY, REWIND TAPES AND INCREMENT TRAIN NUMBER BY ONE

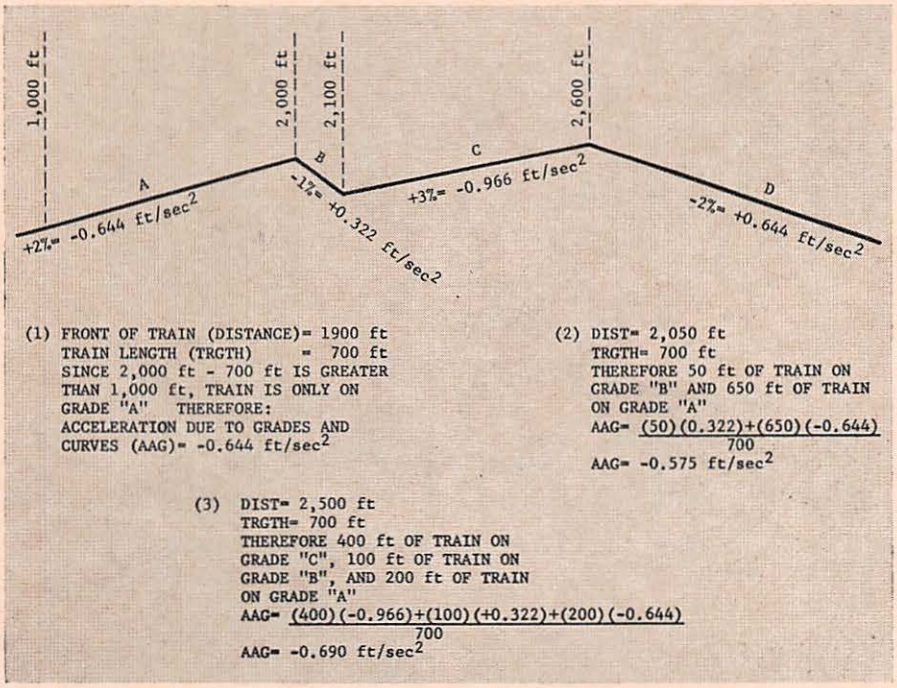
The second portion of the program determines the acceleration due to grades and curves which the train will experience during the second which is being calculated. This value will be a function of train position (distance from chaining zero) and of the plan and profile of the route. To simplify the models, another program was developed which produced a table of grade change

* *Motoring or to motor: The act of applying positive tractive effort using the propulsion system of the vehicle(s).*

points and curve points along with the acceleration in feet per second per second which a train would experience approaching these change points.

This program required the manual listing of all the grade change points along with the value of the grade in percent. A manually prepared list of curves was also used. This list includes the stationing of the beginning of the curve, the length of the arc of the curve, and the radius of the curve. Curves were then equated into evaluated grades according to the relationship that 711.8 divided by the radius of the curve in feet is equal to an equivalent grade in percent. This is an empirical formula derived from experiments. The table of grade changes and curve changes was then collated and the values of the grades were converted from percent into feet per second per second. The resulting table consisted of a list of distances from chaining zero along with acceleration in feet per second per second from the last change point. A sign convention was adapted whereby positive accelerations aid motoring and negative accelerations aid braking. This table was recorded on magnetic tape for use by the computer.

2: Grade and curve acceleration calculations.



(1) FRONT OF TRAIN (DISTANCE)= 1900 ft
TRAIN LENGTH (TRGTH) = 700 ft
SINCE 2,000 ft - 700 ft IS GREATER THAN 1,000 ft, TRAIN IS ONLY ON GRADE "A" THEREFORE:
ACCELERATION DUE TO GRADES AND CURVES (AAG)= -0.644 ft/sec²

(2) DIST= 2,050 ft
TRGTH= 700 ft
THEREFORE 50 ft OF TRAIN ON GRADE "B" AND 650 ft OF TRAIN ON GRADE "A"

$$AAG = \frac{(50)(0.322)+(650)(-0.644)}{700}$$

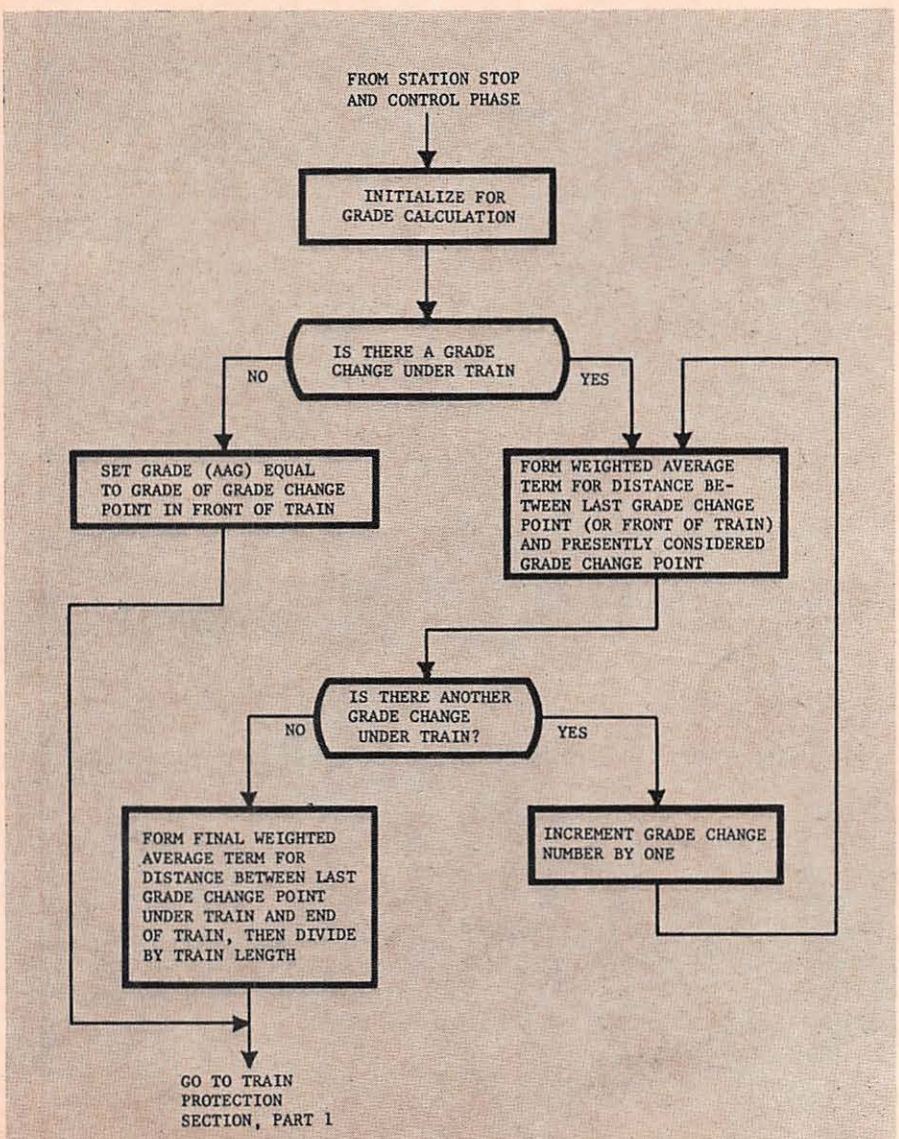
AAG= -0.575 ft/sec²

(3) DIST= 2,500 ft
TRGTH= 700 ft
THEREFORE 400 ft OF TRAIN ON GRADE "C", 100 ft OF TRAIN ON GRADE "B", AND 200 ft OF TRAIN ON GRADE "A"

$$AAG = \frac{(400)(-0.966)+(100)(+0.322)+(200)(-0.644)}{700}$$

AAG= -0.690 ft/sec²

3: Program for acceleration calculations.


FROM STATION STOP AND CONTROL PHASE
INITIALIZE FOR GRADE CALCULATION
IS THERE A GRADE CHANGE UNDER TRAIN
NO
YES
SET GRADE (AAG) EQUAL TO GRADE OF GRADE CHANGE POINT IN FRONT OF TRAIN
FORM WEIGHTED AVERAGE TERM FOR DISTANCE BETWEEN LAST GRADE CHANGE POINT (OR FRONT OF TRAIN) AND PRESENTLY CONSIDERED GRADE CHANGE POINT
IS THERE ANOTHER GRADE CHANGE UNDER TRAIN?
NO
YES
FORM FINAL WEIGHTED AVERAGE TERM FOR DISTANCE BETWEEN LAST GRADE CHANGE POINT UNDER TRAIN AND END OF TRAIN, THEN DIVIDE BY TRAIN LENGTH
INCREMENT GRADE CHANGE NUMBER BY ONE
GO TO TRAIN PROTECTION SECTION, PART 1

In order to calculate the acceleration due to grades and curves experienced by the train, it was decided to consider the train as a tightly coupled uniform line mass. Examples of the method used to calculate grades and curves acceleration is shown in Figure 2.

In example 1 the train's front end is 1900 ft from chaining zero. Since the train is 700 ft long, the train is standing entirely on grade A. Therefore, the train will experience an acceleration due to grades and curves of −0.644 ft per second per second.

In example 2 the train's front end is at 2050 ft. That means that 50 ft of the train is on grade B and is subject to an acceleration due to grades and curves of 0.322 ft per second per second while 650 ft of the train is on grade A and is subject to an acceleration of −0.644 ft per second per second. Therefore, the entire train is subject to an acceleration which is the weighted average of the acceleration experienced by each part of the train which is on a different grade.

In the third example, the front of the train is at distance 2500 ft which means that 400 ft of the train is on grade C and subject to an acceleration of −0.966 ft per second per second, 100 ft of the train is on grade B and subject to an acceleration of

0.322 ft per second per second while the remaining 200 ft of the 700 ft long train is on grade A and subject to an acceleration of −0.644 ft per second per second. The effective acceleration of the train due to grades and curves would then be the sum of the lengths of the train on each grade multiplied by the value of acceleration of the grade divided by the total train length.

Figure 3 shows the flow chart for that portion of the program which calculated the acceleration due to grades and curves according to the above method.

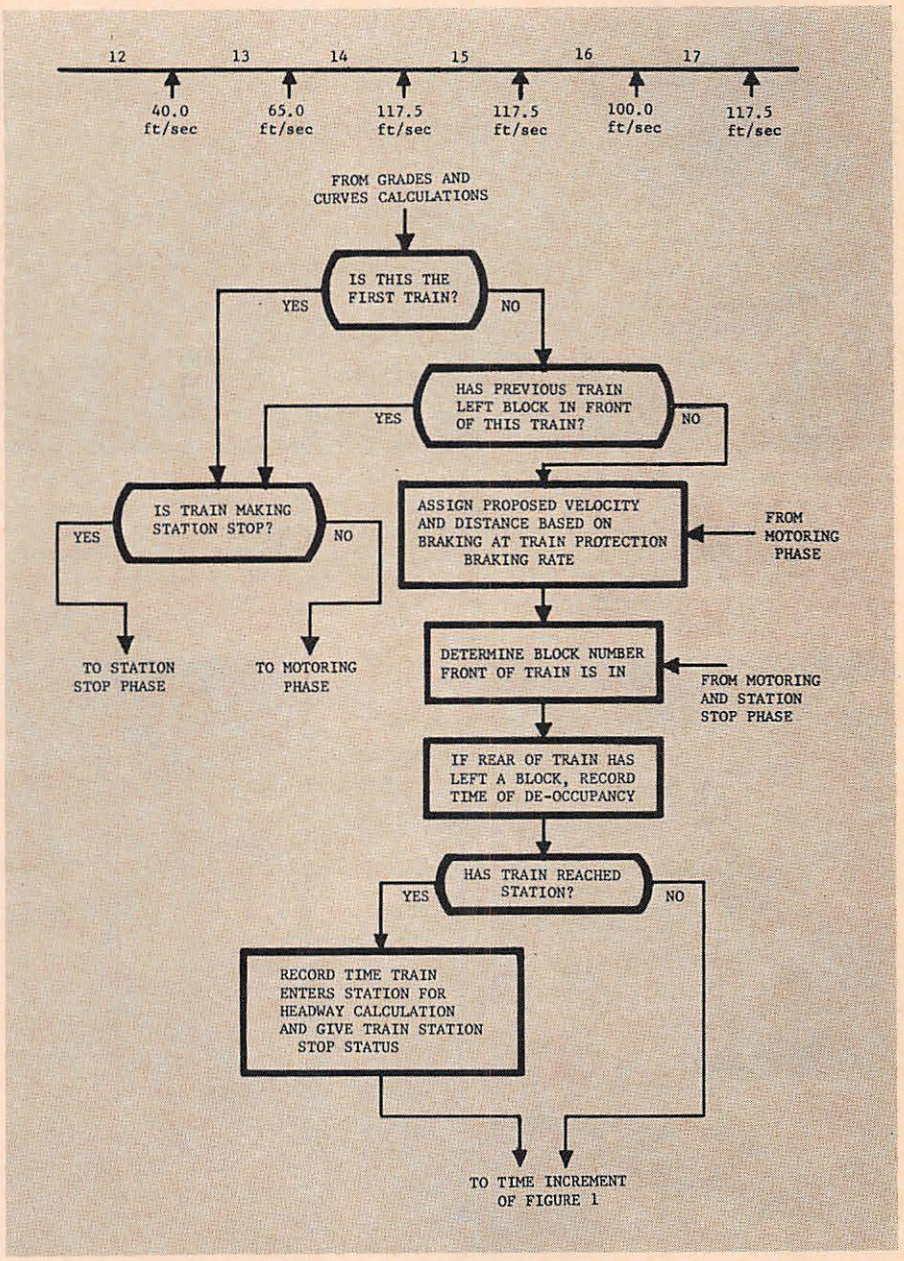
It can be seen that this method introduces certain minor errors. For instance, the train is assumed to have the same acceleration during the entire second that it had at the beginning of the second. Also, the intersection of grades are at points instead of at vertical curves, and no weight transfer between the sections of the train on different grades is assumed.

The portion of the program which enforces train protection for the fixed block model is shown in Figure 4. The top of the diagram shows a typical stretch of rapid transit line (or railroad) with blocks 12-17. The block signal system requires that there must exist one deoccupied block in front of a train other than the block in which the train is located for the train to motor. Otherwise, the train will brake at the predefined train protection braking rate. Thus, a train in block 13 must recognize that block 14 is unoccupied in order for it to proceed.

Also associated with each block is a maximum speed limit for the block. The speed limit might be due to the requirements of the block signal system (the length of the block determines the speed from which braking can be accomplished safely within one block length) or due to local conditions such as grades, curves, etc.

The model records the block numbers occupied by each train on a second by second basis. This is done by reading into the computer a table containing block numbers, the location of the block ends (in feet from chaining zero) and the maximum speed permitted in the block. During the operation of the model, the time at which the rear end of a train left a block is recorded for use in the protection of the following train.

4: Program for enforcing train protection.



If train protection is required, the train is assumed to decelerate at the preassigned train protection braking rate. If train protection is not required, the train is permitted to motor or otherwise operate in accordance with the program.

The first train operating through the system requires no train protection. However, a table of time that it leaves each of the blocks is compiled for use in protecting the second train. For instance, the following leaving times might be recorded:

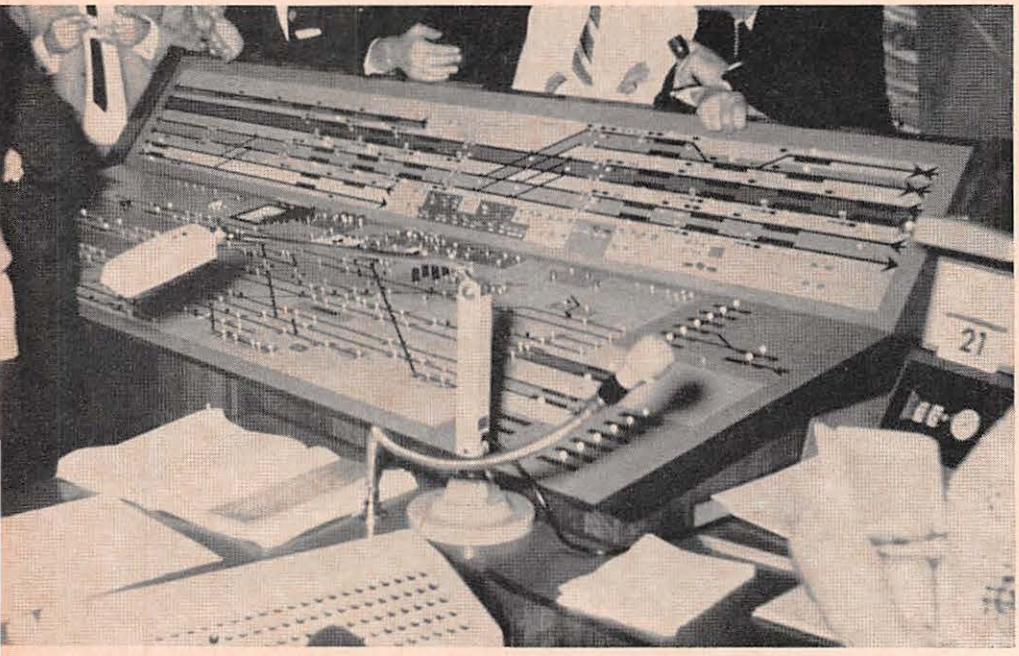
Block Number	Time Block Cleared
14	1250 seconds
15	1313 seconds
16	1400 seconds
17	1440 seconds

If the second train is in block 13, for instance, it is required that no train (that is the first train) can be in block 14 if motoring of the second train is to be permitted. Thus, if the second train reaches block 13 at the time equal to 1250 seconds or earlier, there will be a train in block 14 and motoring in block 13 will not be permitted. The train upon entering block 13 will then brake at the train protection braking rate until either it stops or block 14 is cleared. If a train reaches block 13 after 1250 seconds, it may motor all the way through block 13.

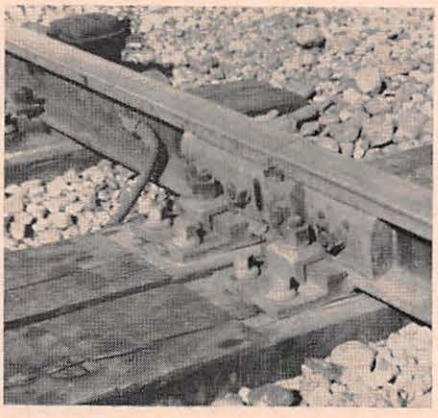
The portion of the program enforcing train protection for the vari-

(Please turn to page 24)

Germany: Munich's Main Station is the scene of 1,000 train movements and 5,000 switching moves daily. Movements into and out of the 36-track stub-end station are controlled by over 400 signals. These signals and nearly 300 power switches were formerly controlled from 11 electro-mechanical interlocking plants. Also, approaches to the station were controlled by 6 other towers. Now, all 17 interlocking plants are controlled from one central tower.



Germany: One of the four entrance-exit, or route-type control machines that handles traffic into and out of Munich's Main Station. Black dashes in track diagram on upper portion of control machine will contain train numbers and destination codes. These are dialled in by outlying interlocking operators and the destination code and train number will progress along the panel as a train moves through the interlockings.

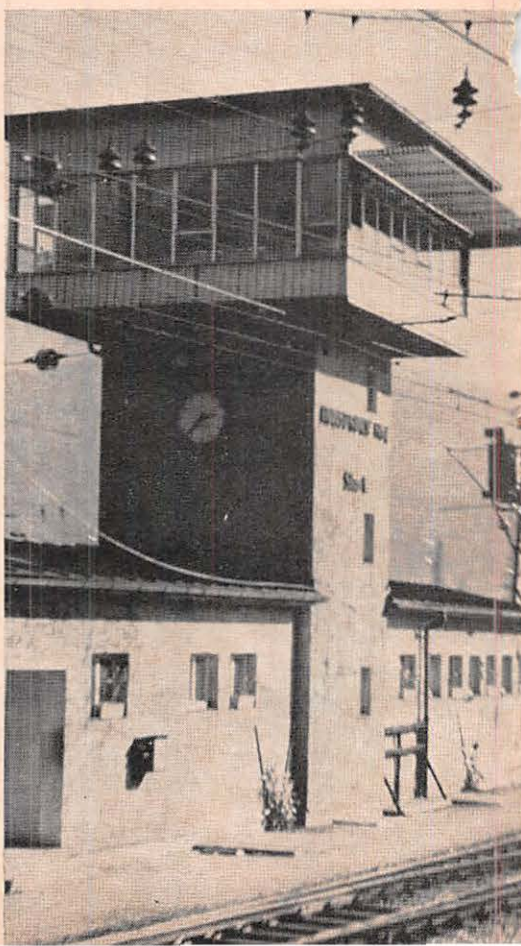


Netherlands (left): Epoxy insulated rail joint is supported by two ties. Such support is typical of European practice, except in Great Britain. Photograph was taken in electrified territory. The two supporting ties may be one inch apart.

Austria (right): Interlocking tower at Innsbruck has large clock visible from the yards. Flower boxes at the windows and shrubs and flowers around yard offices, stations and interlocking towers are a common sight.

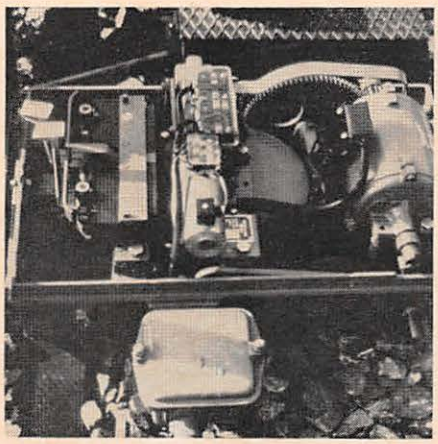
Signalman looks at Europe's railways

Last fall, Richard A. Mather, assistant engineer in the signal and communications department of the Belt Railway of Chicago, spent three weeks in Europe. Specifically, he went to see the giant transportation exhibit in Munich, Germany. However, he also visited several other countries. Armed with a camera, he made a photographic record of his trip. A brief sampling of European signaling practices are presented from his photographs. Our thanks to Dick Mather for letting us give our readers a view of some railway signaling in Europe.

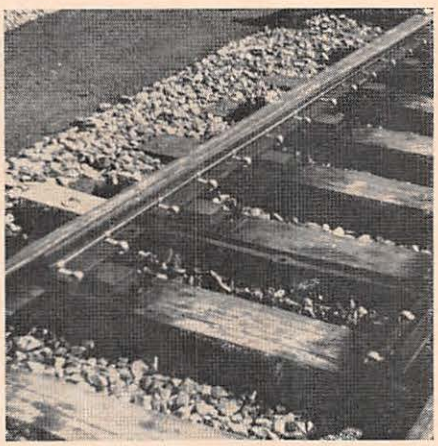


Netherlands: A program of replacing manual gates with automatic half-gates is now under way. About one-third of a possible 600 crossings have been equipped with automatic half-gates and flashing-light signals. Two crossbucks indicate double track, and striping is red and white. Crossings are illuminated with mercury-type street lights. Netherland Railways has found that automatic half-gates have reduced the number of cars waiting at a crossing. A study showed that only 6 cars (on average) are waiting at lowered half gates as contrasted to 25 waiting at lowered manual gates (full barriers). Estimates are that automatic half-gates reduce the loss of time for road traffic to 25%.

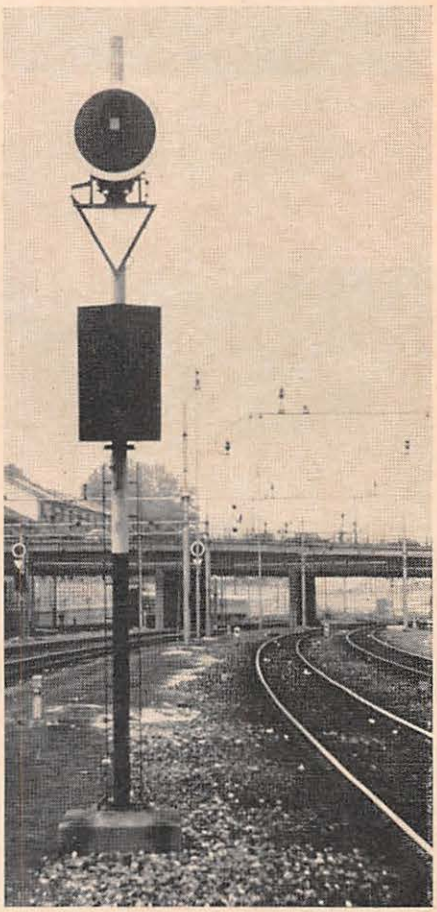
Netherlands: At this double-track crossing, the number of tracks is indicated by two crossbucks. Above the flashers and below the crossbucks is a single yellow light that flashes to indicate that the crossing protection is working properly. This light is extinguished when a train hits the approach circuit and the flashing-light signals begin operation.



Germany: Mainline power switch at the Munich transportation exhibition. Terminals (center of picture) are where point detection is determined electrically. Motor is at right.

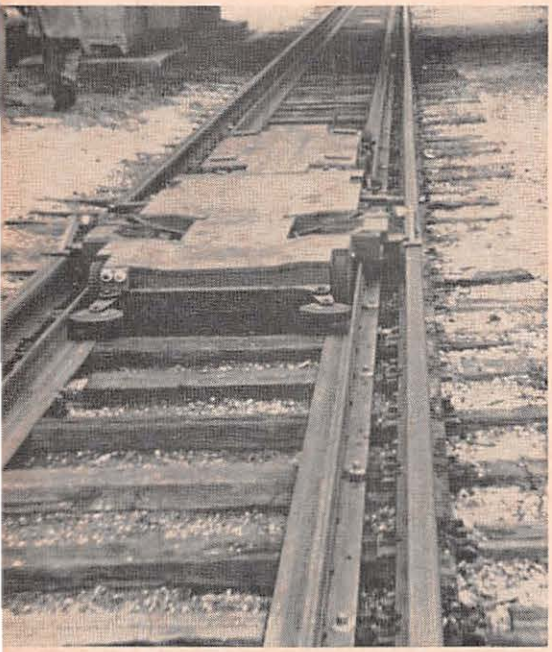


Germany: Rod-type electric switch heater is attached to switch points. This is different from U.S. practice where attachment is to the stock rail.

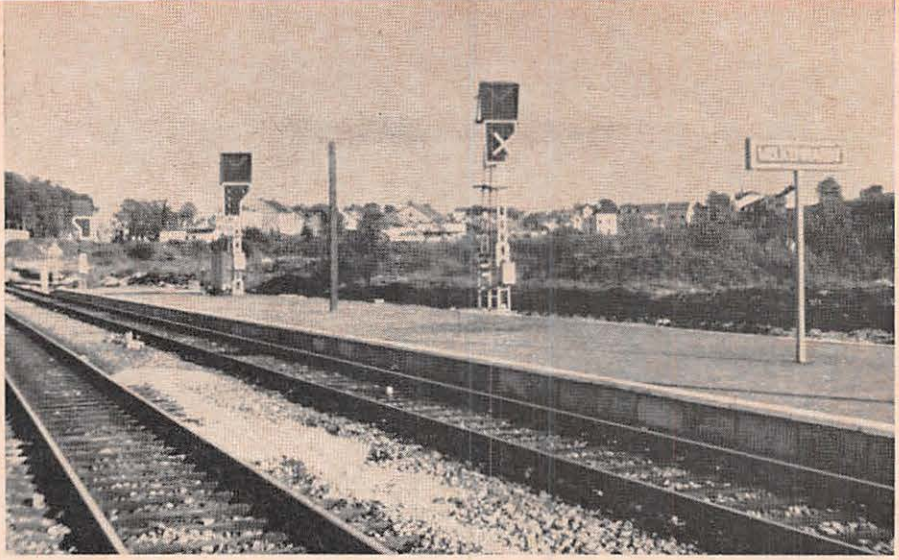


Italy: Searchlight signal is to left of track over which it governs. Italy has left-hand running. White triangle indicates that it is an absolute signal. A number appearing in the black rectangle indicates train speed over the route governed by the signal. For example, 5 means 50 kilometers per hour. Cover glass has cutout so aspect presented is square.

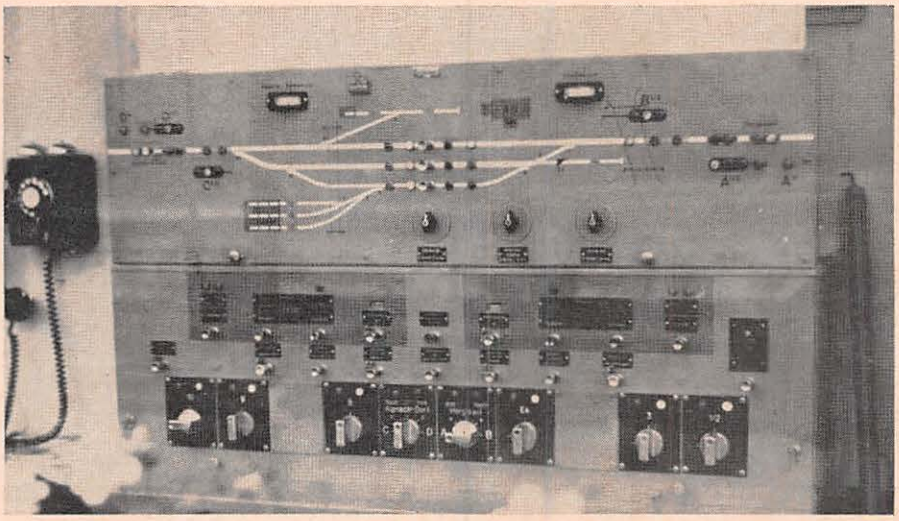
Austria: Home signal has red light in center with green on top and yellow on the bottom. "H" indicates Halt, and is location where train is to stop when pulling into station.



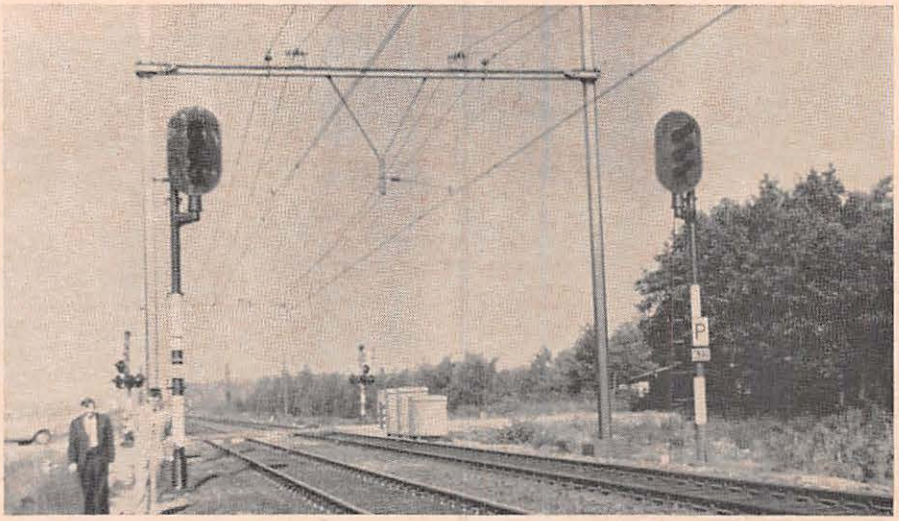
France: New type of retarder on test. Car coming down grade catches up to the unit that is motor driven. Car wheels touch "feelers" on the unit, which runs along the track with the car. Retarding device brakes to a stop at the proper location for the car. Feelers are retracted and the unit returns toward the hump to pick up the next car to be taken to a classification track.



Belgium: Signals at last Belgium station before entering Germany. New signal ("X", foreground) is not yet in service. Top unit has white "Y" indicating that train is going from left-hand running (Belgium) into right-hand running (Germany). Signal aspects are green at top, red at center and two yellows (one at bottom and one at top alongside the green). Yellow aspect is provided by displaying two yellow lights inclined 45 deg. upward to the right.



Switzerland: Typical town interlocking with control machine in the depot. In addition to switch and signal control, operator has control of highway crossing signals (at right of passing track on control panel).



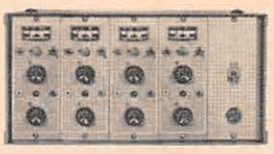
Netherlands: This electrified line has reverse running on both tracks. It is anticipated that centralized traffic control will be installed in the near future. Control is now from various interlockings spaced along the line.

Pennsy goes Ve-Det!

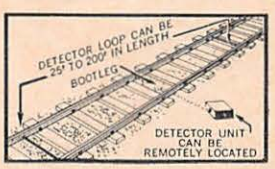
INSTALLS RELIABLE NEW RCA SYSTEM OF RAILROAD CAR PRESENCE DETECTORS IN CHICAGO YARD

Says H. H. Vaughn, Assistant General Manager, Western Region, Pennsylvania Railroad, "Our new RCA VE-DET Car Detection System is providing fail-safe, true-presence detection . . . which means true efficiency. Installed in our new 59th Street retarder-controlled hump yard in Chicago, the RCA VE-DET presence detectors prevent the switches from being thrown when cars occupy a switch. This is far superior to other methods and is saving us time and money. We're proud of the service we can render."

VE-DET emphasizes solid state circuitry, modular construction. It is easy to install and maintain, requires no insulated rail joints. The detection loop circuit is formed directly in front and back of switch points by shunting a short section of track. Such a circuit will detect the presence of a car as long as any portion of it is over the loop. A total of four detectors and one power supply are mounted in one enclosure which can be located up to 1,000 feet from the loops.



RCA VE-DET mounts up to four detectors and one power supply in one enclosure.



How VE-DET works.

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(Continued from page 19)

able block model is shown in Figure 5. The train protection system for the variable block model maintains safe braking distance between leading train and following train. This safe braking distance is the distance required to stop (plus margins) from the following train's speed at the train protection deceleration rate. The margins adopted were an increase in the braking distance by 25% and a decrease in the assumed train protection deceleration rate an amount equal to the acceleration due to the steepest grade on the system (4%). This assumes that a train is incapable of determining the average acceleration acting on it due to grades and curves. Although these margins are used in the calculation to determine whether or not the train should brake for train protection, the actual performance, of course, will be based on the conditions actually experienced by the train without margins.

The portion of the program which determines the proposed new train velocity and position if motoring when the train protection is not required is shown in Figure 6.

The rules for determining the acceleration due to motoring approximate curves of acceleration versus speed for a proposed vehicle for the BARTD system. They take into account the friction and windage train resistance.

A proposed velocity for motoring is obtained by combining the present velocity with the acceleration due to motoring and the acceleration due to grades and curves. This proposed velocity is tested against the speed limit. If it is less than the speed limit it is accepted. If it is greater than the speed limit, a new proposed velocity due to coasting is tried. If this is less than the speed limit it is accepted. If it is greater than the speed limit, the train will brake at any rate up to the maximum train protection braking rate in an effort to get under the speed limit.

Figure 7 shows the portion of the program involved in making a station stop. Another program generates a table of distance versus velocity on a second by second basis for a train making a stop at each station. This table is stored on tape and is used in the running of the fixed block and variable block models. When the imaginary graph of the train's velocity distance curve crosses the imaginary graph of the station stop's velocity distance curve the train operation is changed from the free running mode to a mode during which performance follows the station stop curve. Thus, the train will run as if no station existed until the time at which the train must start braking for the station in order to make a stop from the velocity at which it was traveling. At that time, the train will brake at a station stop deceleration rate (3.15 ft per second per second due to brakes) and stop at exactly the correct point in the station. Grades and curves are, of course, also taken into consideration.

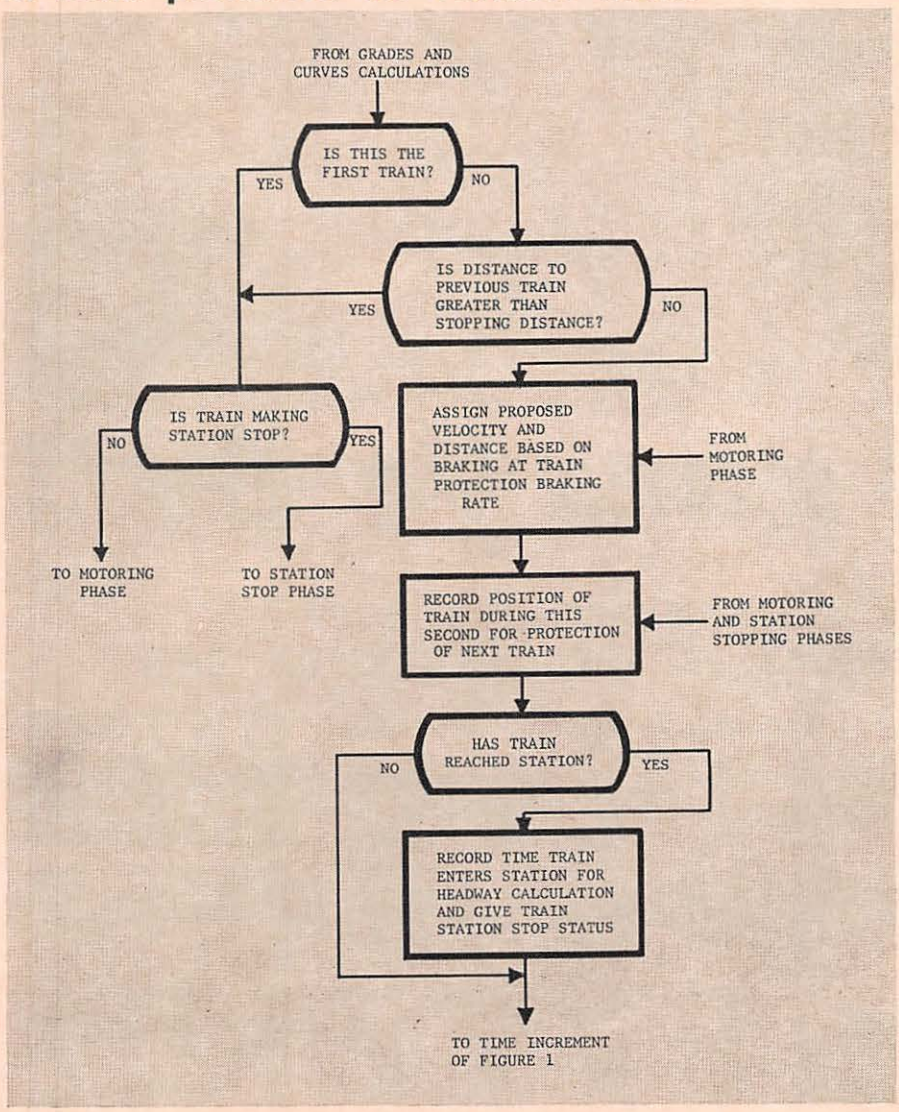
Running the computer model for the moving block system produced the results described above. It was found that if trains were inserted into the system at 30 second intervals, that is, a new train is inserted 30 seconds after the last train left, the characteristics of the system are as shown in Figure 8. The level part of the curve at 55 second headway represents a steady state condition. During this steady state condition, the nth train does exactly what the (n—1)th train was doing at the same point.

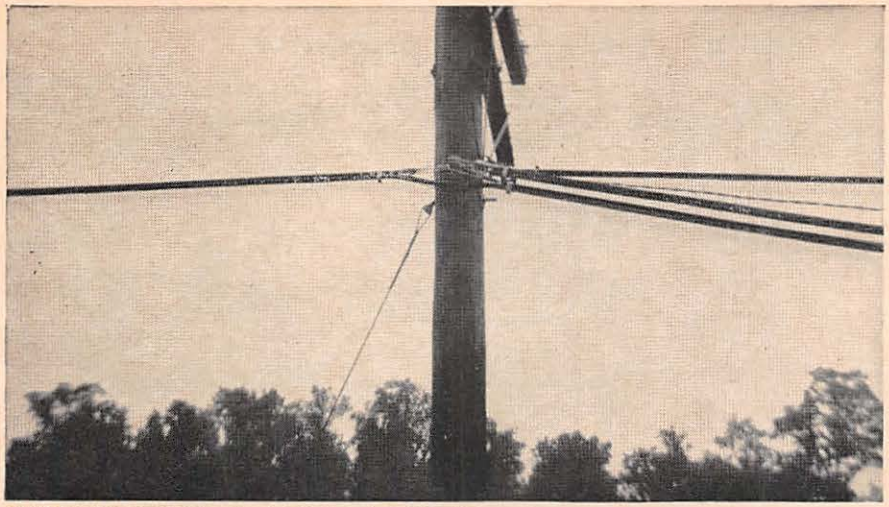
This suggested the possibility that the steady state condition represented the most efficient form of train operation from a capacity and speed point of view. Thus, if each block's speed limit were established for a fixed block system in such a way that it would force a train to closely approach the operation under steady state conditions of a moving block model, the advantages of a moving block system might be realized.

A block locating program was devised which would locate the block points for a fixed block system. This program made the initial assumption

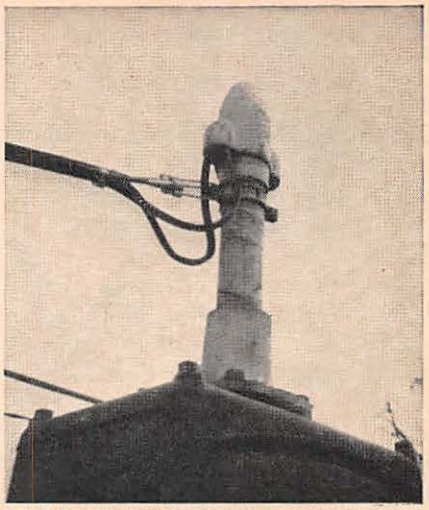
(Please turn to page 26)

5: Train protection for variable block.

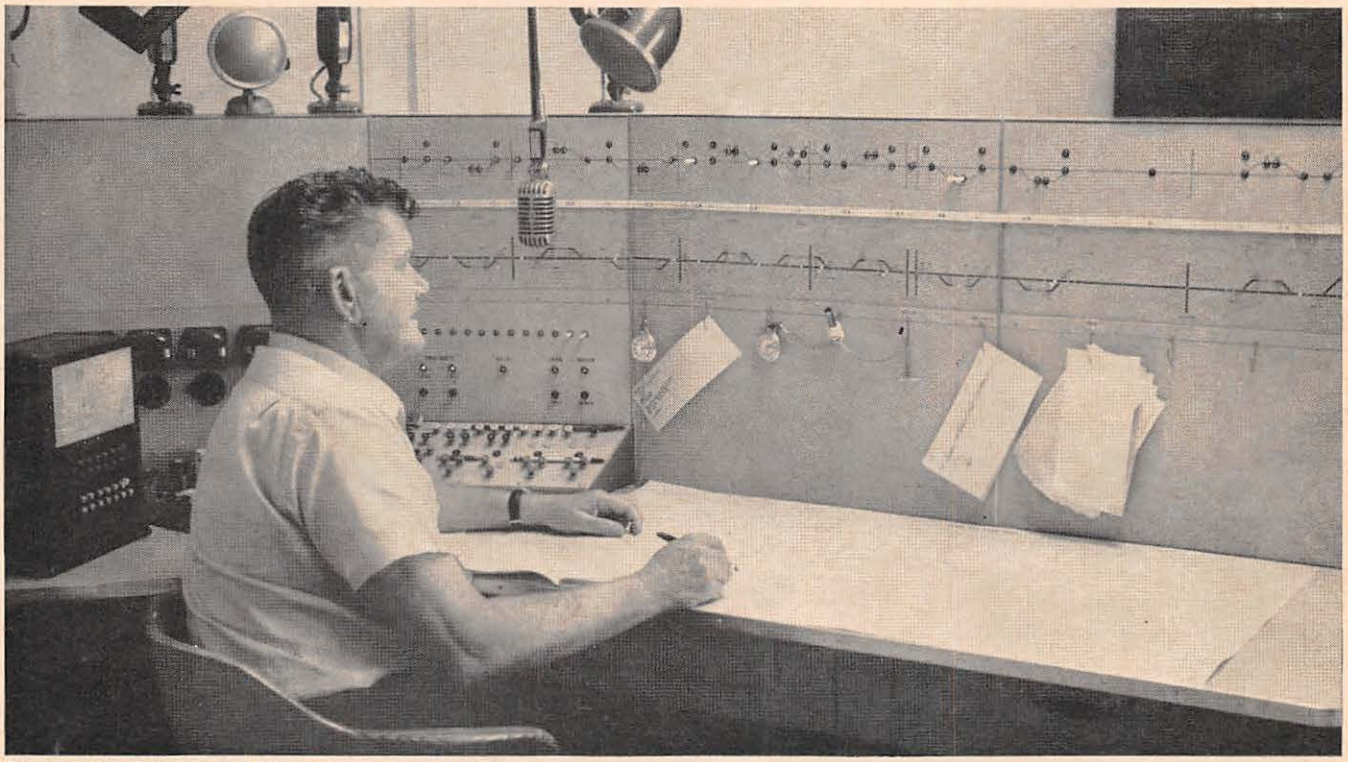

FROM GRADES AND CURVES CALCULATIONS
IS THIS THE FIRST TRAIN?
YES
NO
IS DISTANCE TO PREVIOUS TRAIN GREATER THAN STOPPING DISTANCE?
YES
NO
IS TRAIN MAKING STATION STOP?
NO
YES
ASSIGN PROPOSED VELOCITY AND DISTANCE BASED ON BRAKING AT TRAIN PROTECTION BRAKING RATE
FROM MOTORING PHASE
TO MOTORING PHASE
TO STATION STOP PHASE
RECORD POSITION OF TRAIN DURING THIS SECOND FOR PROTECTION OF NEXT TRAIN
FROM MOTORING AND STATION STOPPING PHASES
HAS TRAIN REACHED STATION?
NO
YES
RECORD TIME TRAIN ENTERS STATION FOR HEADWAY CALCULATION AND GIVE TRAIN STATION STOP STATUS
TO TIME INCREMENT OF FIGURE 1



ATRR-8 cable leaving terminal pole at a signal location.



ATRR-8 cable terminating at a signal case.



Dispatcher W. E. Martin at CTC panel in Houston, Texas.

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This is quite an unusual application for our 300 volt high reliability ATRR-8 Communication Cable. But it's the right cable for the job. In addition to signal circuits, this cable provides a voice circuit for maintainers and a fall back dispatcher circuit. 3 pair and 6 pair #14 AWG ATRR-8 cables were installed between Kinder and Anchorage. And every foot of cable was water-tested according to Anaconda ATRR cable specifications.

For full details on the application of ATRR cables in railroad and transit systems, call your Anaconda man. Or write Anaconda Wire and Cable Company, 605 Third Avenue, New York, N. Y. 10016.

ASK THE MAN FROM **ANACONDA®**
ABOUT ATRR CABLES

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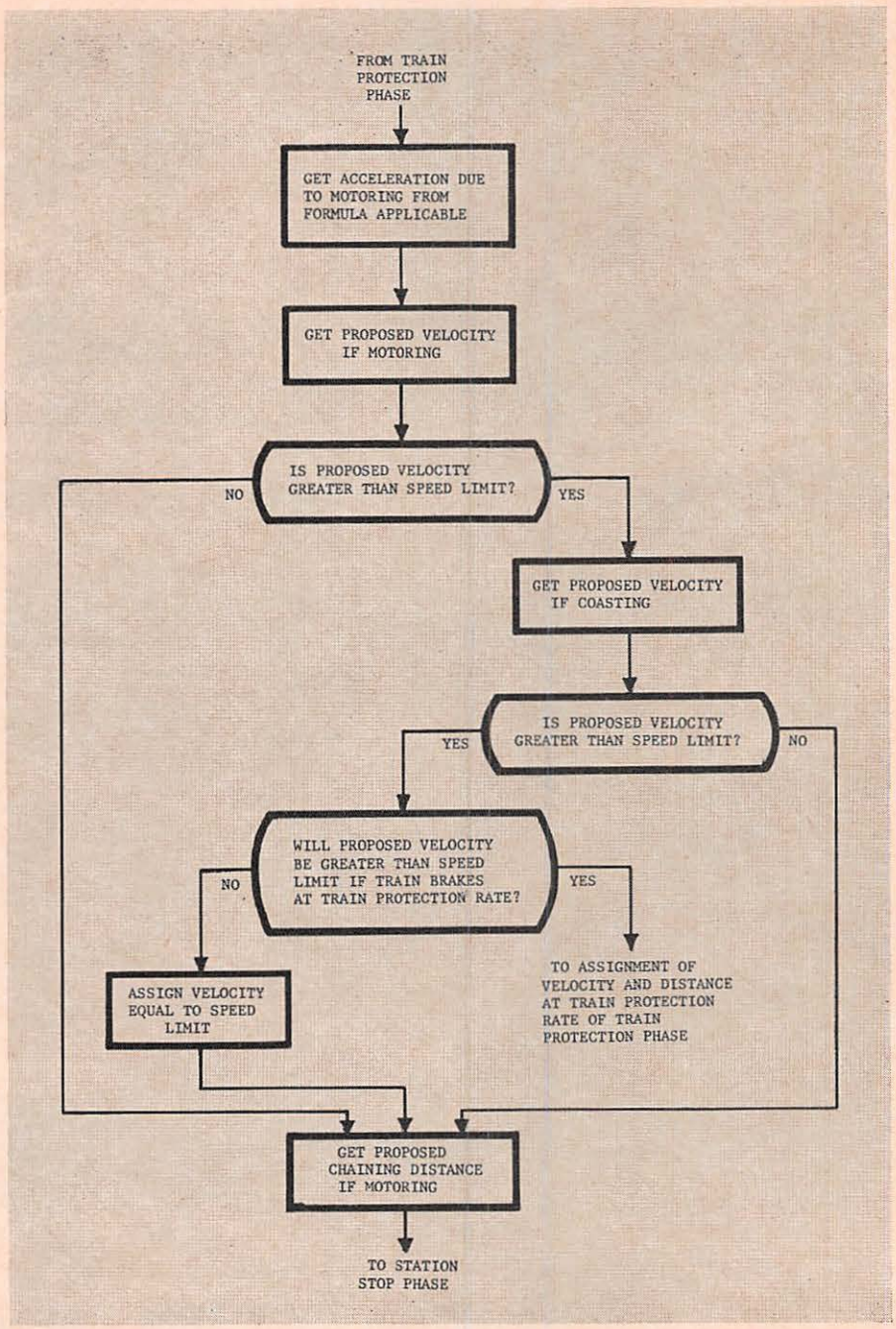
(Continued from page 24)

that the best place to locate a block point is always at the entering end of a station. This appeared to be a good assumption in view of the fact that this block point would immediately be cleared when a train makes a station stop. If this block point were located at any other place, it would either be cleared sooner or cleared much later. From the location of this block point, other block points in the vicinity of the station are determined. After the block points in the vicinity of a given station are determined as described below, the block points in the vicinity of the next stations are determined. Then the location of block points between the stations are matched by hand. This hand matching process is not critical since it takes place in an area where it is possible to attain headways less than those which can be attained in the vicinity of stations.

FIND BLOCK POINTS

A detailed description of the method used, shown in Figure 9, now follows: first, a time-distance-velocity curve of a train running at steady state condition of a moving block model is generated. This train will obey the speed restrictions necessary because of grades, curves, etc. as well as the speed restrictions naturally generated by preceding trains. Next, from the first block point which is established at the entering end of a given station platform and is called point "A", a "B" point is established braking distance behind the "A" point. This means that a train reaching the "B" point at the maximum attainable speed (as indicated in the steady state distance-velocity curves) will be able to stop with margin at the "A" point while braking at train protection braking rate. A "C" point is then established behind the "B" point. This "C" point is located at the point at which the front of a train will be at the time when the rear of the train ahead just clears the "A" point. The "C" point is at least stopping distance plus margins behind the "B" point. Additional points in back of the "B" point and the "C" point are located braking distance from these points. Block points ahead of the "A" point are located braking distance from the "B" point and the "A" point.

6: Velocity without train protection.


FROM TRAIN PROTECTION PHASE
GET ACCELERATION DUE TO MOTORING FROM FORMULA APPLICABLE
GET PROPOSED VELOCITY IF MOTORING
IS PROPOSED VELOCITY GREATER THAN SPEED LIMIT?
NO
YES
GET PROPOSED VELOCITY IF COASTING
IS PROPOSED VELOCITY GREATER THAN SPEED LIMIT?
YES
NO
WILL PROPOSED VELOCITY BE GREATER THAN SPEED LIMIT IF TRAIN BRAKES AT TRAIN PROTECTION RATE?
NO
YES
ASSIGN VELOCITY EQUAL TO SPEED LIMIT
TO ASSIGNMENT OF VELOCITY AND DISTANCE AT TRAIN PROTECTION RATE OF TRAIN PROTECTION PHASE
GET PROPOSED CHAINING DISTANCE IF MOTORING
TO STATION STOP PHASE

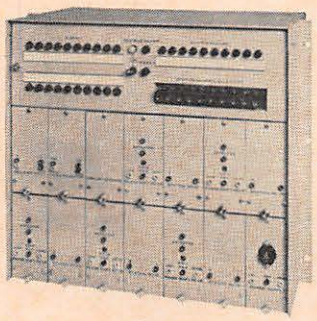
Since block points established by this method do not permit braking from the maximum attainable speed, it is necessary to establish speed limits for each block. These speed limits are established to permit the train to stop within one block length.

Figure 8 shows the results of running the fixed block model with the block points established using this block locating program. From this figure it can be seen that although the minimum attainable headway is greater than that of the moving block model the headway can be realized immediately. This system characteristic can be explained by considering that the fixed block system tends to discipline the train movement. Thus, although a train may not start quite as soon as it would under a moving model, for instance, once it does start it is capable of maintaining its pace. The block system therefore paces the operation of the trains.

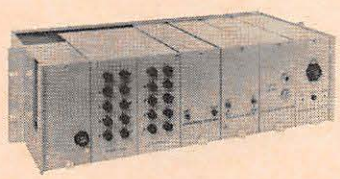
An analogy to this comparison between the fixed and moving block systems can be thought of as follows: Assume a room filled with many people milling about. An order is given to form a straight line. It would take

(Please turn to page 28)

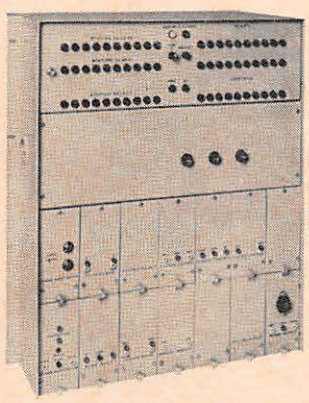
Noller Packaged Systems for solid state microwave alarm and control are matched to your exact requirements



For example... If you want accurate alarm information, there's the NP453 series of continuous-reporting alarm and status monitoring systems. Various versions monitor and display up to 35 status and alarm reports from each of 10 remote locations.



Do you want fail-safe control? You can rely on the high-security of the NP463 control system. Its special coding techniques insure fail-safe operation even under the most severe noise conditions. Standard models use a single channel frequency to control up to 10 separate functions at each of 10 remote locations.



To combine alarm and control for maximum system supervision, specify the NP431 two-directional, high security alarm and control system. It uses single channel frequency in each direction to control up to 10 functions and receive and display up to 19 alarm and status reports from each of 10 remote locations. If you need more capacity, use the NP432 system. It gives you 35 alarms and 25 controls at each remote location. Need more locations per master station? Use the NP433. It handles 19 alarms and 25 controls at each of up to 100 remote locations.

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(Continued from page 26)

the people quite a bit of time to adjust themselves into the straight line. They would make minor adjustments and corrections by moving back and forth until they were satisfied that the line was straight. If, however, in this same room of milling people there were a number of chalk marks on the floor indicating the position people were to assume if a straight line were required, and the command were given, it would be a relatively quick operation for people to reach their assigned chalk marks and form the straight line.

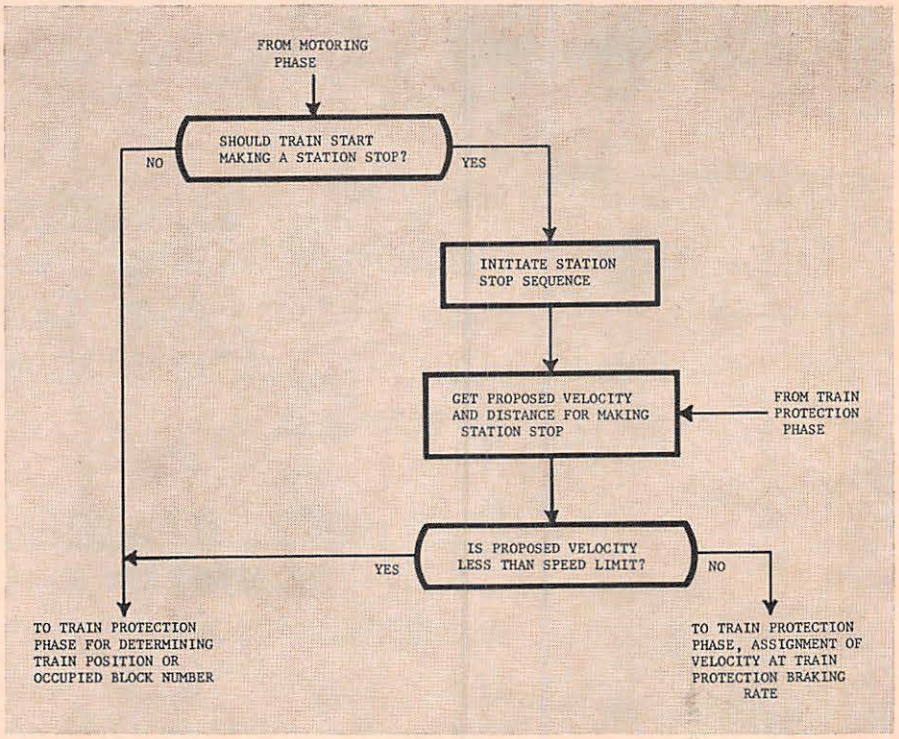
LOCATING BLOCKS

The disadvantage to locating blocks by this fixed block method is that permanent speed restrictions are required for each block. Thus, the average speed of the train between terminals is reduced whether or not the extra capacity provided is needed at all times. The amount of this speed reduction is about 5%. To examine the possibility of developing locations which would not require the use of speed limits due to block lengths, a fixed block system was laid out based upon the free-running curves of the train. These curves are the time-distance-velocity curves generated by a train running from one terminal to another making the necessary station stops but not observing any speed restrictions other than those required by curves, etc.

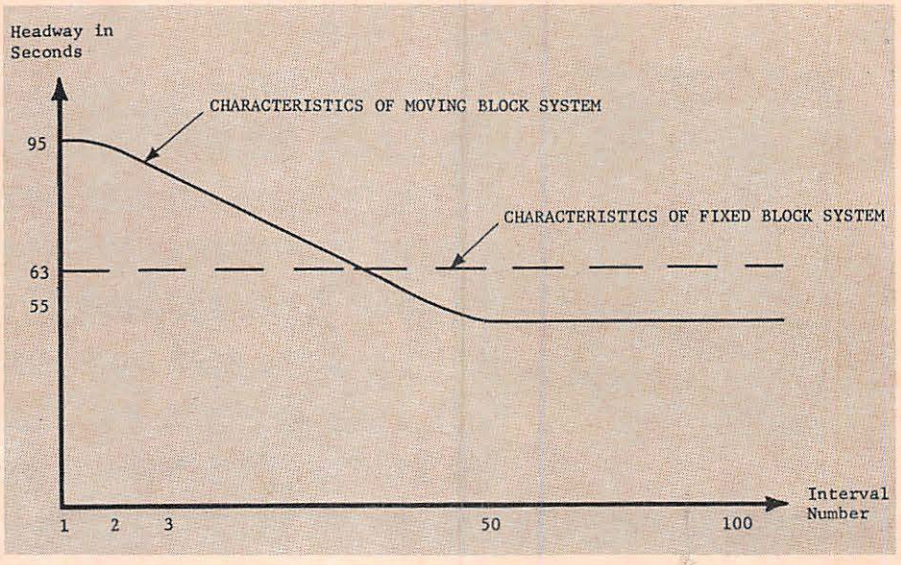
Trails of these block locations using the fixed block model indicate that a 66 second headway can be maintained. The increase in average velocity, though, was only minor during rush hours.

From these studies it can be seen that a fixed block system offers important advantages over a moving block system for rapid transit operation. These advantages include instantaneous response to step function changes of dispatched headway such as caused by the insertion of extra trains during rush hour, and immediate recovery from delays due to breakdowns although the variable block system has an ultimate minimum headway, achieved only after running many trains about 15% less than minimum headway of a fixed block system. **RS&C**

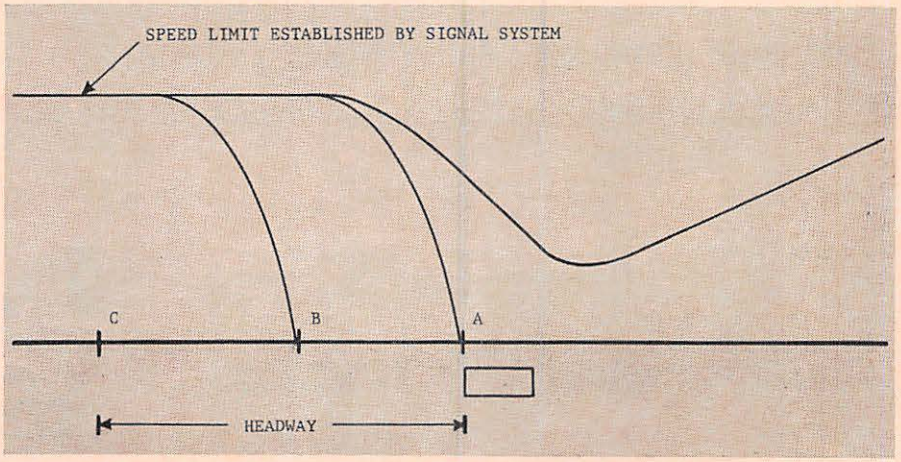
7: Program for making a station stop.


FROM MOTORING PHASE
SHOULD TRAIN START MAKING A STATION STOP?
NO
YES
INITIATE STATION STOP SEQUENCE
GET PROPOSED VELOCITY AND DISTANCE FOR MAKING STATION STOP
FROM TRAIN PROTECTION PHASE
IS PROPOSED VELOCITY LESS THAN SPEED LIMIT?
YES
NO
TO TRAIN PROTECTION PHASE FOR DETERMINING TRAIN POSITION OR OCCUPIED BLOCK NUMBER
TO TRAIN PROTECTION PHASE, ASSIGNMENT OF VELOCITY AT TRAIN PROTECTION BRAKING RATE

8: Characteristics of the two systems.



9: Establishing block points.



General Electric designed and installed the country's largest private microwave system

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What's more, plans have already been announced to more than double the present system of 1,900 route miles by an additional 2,200 route miles.

Total cost of this modern, reliable, all-weather communications medium will be about $28 million. Southern looks on this as an *investment* in an even safer, even more efficient and reliable railway. Microwave speeds up our system of keeping tabs on the availability of equipment and on the movement of freight. It helps us *keep* freight moving on the demanding schedules our customers require. Overall, it means better, lower-cost, more useful service on Southern Railway.

Adapting new and better methods to railroad operations, or creating them ourselves, is putting "Southern's accent" where it belongs — on the things that help us increase our usefulness to customers. All in the South benefit.

D. W. Brosnan
PRESIDENT

Southern Railway System
WASHINGTON, D. C.

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Track Circuits - NON-CODED DC

Until now we have been dealing with neutral relay track circuits, which necessitates the use of line wires for signal control circuits. In localities where there is no pole line existing, the polarized relay track circuit may be used. The neutral relay conveys only two conditions; that is, energized or de-energized.

The polarized relay conveys three conditions: namely, energized normal, energized reversed, or de-energized. With this polarized feature available, three-indication signaling can be provided without the use of line wires (see Fig 16).

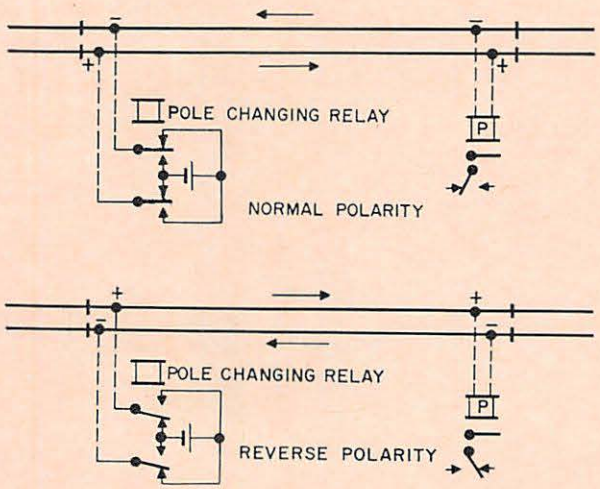


Fig. 16 POLARIZED RELAY TRACK CIRCUITS

Like any other relay, track occupancy, broken rail, or any of the other conditions that cause a neutral relay to be de-energized, will also cause a polarized relay to be de-energized. A pole-changing instrument in the form of a relay, circuit controller on a signal, etc., is used to change the polarity of the rails, which causes the polarized track relay to react correspondingly. Therefore, whatever change takes place at one end of the track circuit will be transmitted to the other end of the track circuit, if it is unoccupied.

Track repeater, or relayed cut-sections, can be provided for polarized relay track circuits in the same manner provided for in neutral relay track circuits.

Needless to say, it is imperative that each track circuit be confined within its own limits. This is the purpose of the insulated joints. Broken-down insulated joints can only mean trouble. Mere visual inspection of an insulated joint is not sufficient. Worn out fibre parts cannot always be detected by visual inspection.

Probably the most undesirable place for an insulated joint to break down is at a battery-relay location where such a breakdown would permit the battery from one track circuit to hold up the relay in the adjacent track circuit, even though it may be occupied.

ABSTRACTED FROM
AAR Signal Section
Visual Aid Training Program

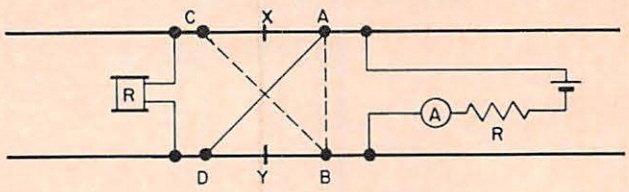


Fig. 17 INSULATED JOINT TEST

To test for broken-down insulated joints, see Fig 17 and proceed as follows:
1. Place a DC ammeter in series with the battery and the rail and read the normal track circuit current.
2. Place a shunt across the rails at points A and B to determine full shunt deflection on the ammeter.
3. Move end of shunt from point B to D to test joint Y. Any appreciable increase in current reading above normal track circuit current indicates breakdown in joint Y.
4. Move end of shunt at point D back to point B. Move end of shunt from point A to point C to test joint X. Any appreciable increase in current reading above normal track circuit current indicates a breakdown in joint X.

The increase in current reading when each joint is tested, as compared with the initial full shunt reading, indicates the extent of breakdown of each joint.

Test should be made when the track is dry to avoid the effect of high ballast leakage.

Where track circuits have fouling circuits in multiple, it is imperative that a shunt on the fouling section will de-energize the track relay. Periodic test on the fouling circuit should be made to determine the effectiveness of a shunt on the fouling section (see Fig 18).

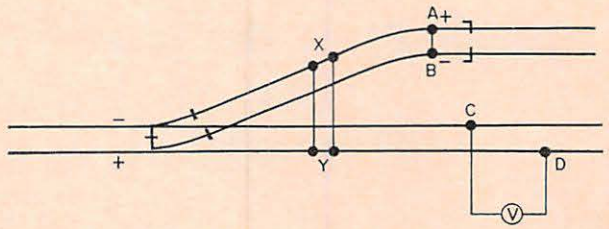
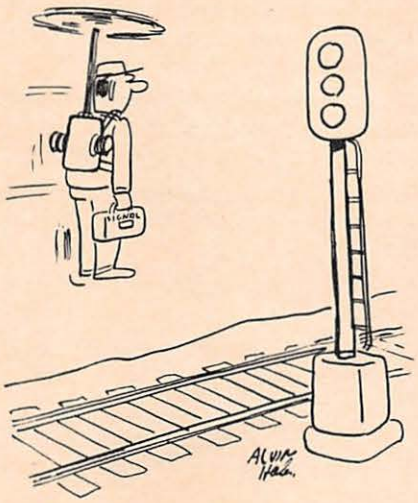
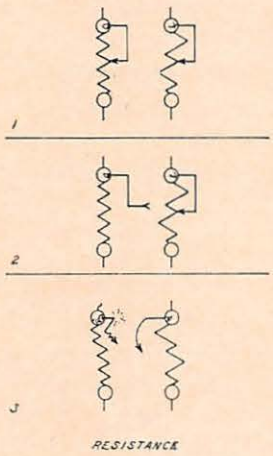


Fig. 18 FOULING CIRCUIT TEST

To test for fouling shunt sensitivity, proceed as follows:
1. Place shunt at points A and B at end of fouling section.
2. Voltmeter when connected at points C and D should have reading near zero.
3. If voltmeter reading does not approach zero, ammeter should be connected at point X from each fouling connector to rail. Similar test should be made at point Y from each fouling connector to rail. Ammeter should also be connected around each bond and rail connector on the fouling section.

WHAT'S THE ANSWER?





Retarder Yard Speeds

Q. How often do you make speed measurements in automatic retarder classification yards? Please describe your practices, involving where such measurements are taken-in relation to master and group retarders for example. Do your measurements include determination of coupling speeds on the class tracks?

A. We feel that speed measurements should be made when it is apparent that the frequency of over speed impacts have increased, or the frequency of cars stopping short, have increased.

Spot checks can be made by the use of stop watches measuring the time it takes the front wheels of a car to travel 39 ft a standard rail length in most yards. A formula we use is: mph = 25.59 ÷ time in sec. We make these tests near the point of coupling, and at the point of tangency of the body track. Since the grade in most yards is supposed to be non-accelerating and non-decelerating, you can then determine if the trouble is caused by deterioration of the body tracks or change of grade in these tracks.

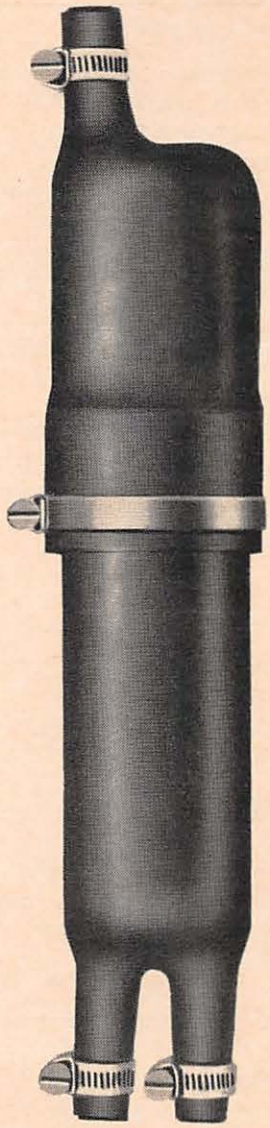
The leaving speed from the group retarders can be determined by reading the output of the velocity meter panels and of course checked with stop watches as stated before. Wheel contactors in connection with recording instruments similar to brush recorders, used on code lines to count and measure impulses in CTC installations, may be used. Three contactors properly spaced and timed will show either acceleration or deceleration of cars.

R. C. Armour, Supervisor Signals, Chesapeake & Ohio, Russell, Ky.

A. At our Cherokee Yard, Tulsa, speed measurements are made semi-annually, late in spring and fall. Speeds leaving the master and speeds entering the groups are checked and classified into weight classes. This data is utilized to adjust leaving speed of the master retarder. At the same time the operation of the modifiers is checked to see that proper modification for rollability is being received by the various cuts. It takes approximately two days for two men to check speeds and make adjustments of release speed at the master regarder.

One man, working from the retarder tower, can check weight, speed leaving group retarder, speed as cut clears curve and action of the retarder operator. Another man is located on the ground to check speeds at about the center of the class tracks. By compiling data ob-

(Please turn to page 32)



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Circle 63 on reader service card

(Continued from page 31)

tained, release speed for various weight cuts can be obtained. This requires approximately two days per group for the two men.

We have found the above to give satisfactory results along with spot checks and occasional adjustments as suggested by retarder operators.

The speed of cuts is obtained by timing the movement over a measured section of track.

G. F. Gross, Communications & Signal Supervisor, St. Louis-San Francisco, Tulsa, Okla.

A. It is our practice to check speed out of retarders, seasonally in the spring and fall, or whenever track conditions are changed in accordance with the following procedures.

Working from a list of cars to be classified, a record is made of: (1) Track fullness, (2) Weight of car, (3) Position of weather switch, (4) Computer requested speed, (5) Actual leaving speed of car out of retarder.

Speed measurement is made over a short distance immediately prior to coupling.

Determination is made from the above information whether or not computer changes are required. Monthly checks are conducted to insure that requested and retarder leaving speeds are in agreement.

F. L. Chatten, System Engineer Communications and Signals Pennsylvania, Philadelphia, Pa.

Microwave Tests

Q. What test procedures have you set up for checking the operation of microwave equipment? Please describe, including types of test gear and how often tests are made?

A. On the Milwaukee Road, we have a single link microwave system, both terminals of which are easily accessible to maintenance personnel at any time. For this reason, we have not had the problem of coordinating tests over a wide geographical area and including isolated equipment locations of difficult access.

The tests made can be divided into two categories: relatively simple ones using built-in switches and meters on the equipment; and more extensive ones requiring external test equipment. Since our microwave terminals are easily accessible and adjacent to other electronic equipment, the former are performed by the maintainer whenever he is in the area, but not less frequently than once per week.

Following is a tabulation of the tests using the built-in equipment and the action taken based on these tests (see top of page).

Tests	Action
(1) Transmit klystron frequency with automatic frequency control off.	Adjust klystron repeller voltage
(2) Transmit klystron beam current.	Deviation from normal indicates trouble developing, requiring further tests to find cause.
(3) Transmit klystron repeller voltage.	Deviation from normal indicates trouble developing, requiring further tests to find cause.
(4) Transmit klystron beam voltage.	Deviation from normal indicates trouble developing, requiring further tests to find cause.
(5) Transmitter power.	Deviation from normal indicates trouble developing, requiring further tests to find cause.
(6) Receiver local oscillator frequency.	Adjust tuning of local oscillator klystron cavity.
(7) Local oscillator klystron repeller voltage.	Change from normal indicates trouble developing, requiring further tests to find cause.
(8) L.O. klystron beam current.	Change from normal indicates trouble developing, requiring further tests to find cause.
(9) L.O. klystron beam voltage.	Change from normal indicates trouble developing, requiring further tests to find cause.
(10) Crystal current.	Adjust local oscillator injection.
(11) Receiver AFC operation.	Adjust klystron repeller voltage, AFC limit and AFC balance.
(12) Monthly-filament activity.	Indicates potential klystron failure.
(13) Monthly-alarm sensitivity & operation.	Adjust as required.

More extensive tests requiring external test equipment are made periodically as required by the maintenance schedule or by law, or more frequently if tests using the internal equipment indicate developing trouble.

Basic equipment required to make these tests are as follows:

(1) Multimeter: General purpose volt-ohm-milliammeter with 20,000-ohm-per-volt sensitivity on DC ranges.

(2) SHF Test Set: Multi-purpose test set used as signal generator, power meter, and wavemeter.

(3) Oscilloscope with 10 mv/cm sensitivity and response to 200 kc.

(4) Wide range signal generator with frequency range of 10 cps to 10 mc. General purpose signal generator.

(5) Vacuum tube voltmeter, bridging db meter and high impedance voltmeter for voice and carrier frequency measurements.

In addition to the foregoing, various test cords, matching transformers, and attenuators are used with the equipment in testing a microwave terminal.

Following is a tabulation of the tests using external equipment: (1)

Check power supply voltages monthly and adjust as required; (2) On a yearly basis, check transmitter frequency. At this time, if necessary, adjust transmit klystron cavity tuning; (3) Check transmitter deviation on a yearly basis. Make adjustments as required for correct deviation; (4) As required in conjunction with multiplex lineups, the baseband levels should be checked and adjusted.

With this schedule of testing, very little trouble has been experienced in the operation of the microwave link.

Robert N. Hettrick, Assistant Communications Engineer,
Milwaukee Road,
Chicago, Ill.

A. Routine tests are made on a monthly basis and include the following:

(1) Condition of primary power source, including batteries, charger and standby generator;
(2) Power supply voltages taken with VOM;
(3) Check of protective and switching diodes using VOM;
(4) Check and adjustment of alarm circuits;
(5) Check for proper operation of AFC circuits;
(6) Check and record transmitter power, receiver crystal current and receiver AGC voltage (these readings taken from built-in metering circuits);
(7) Read and record baseband line pilot levels. (taken with Sierra 126A frequency selective voltmeter.) Items 6 and 7 are compared with original test data to insure against any deterioration of the system.

Annual checks include the following:

(1) Transmitter power (using Hewlett Packard DY-623B SHF test set);
(2) Transmitter frequency (using Frequency Standards 5882-4 frequency meter);
(3) Transmitter modulation (using Hewlett Packard 650A high frequency generator, Hewlett Packard 623B SHF test set, Hewlett Packard 400L VTVM, Dumont 304A oscilliscope);
(4) Receiver sensitivity (using Hewlett Packard 623B SHF test set);
(5) Receiver muting and AGC curve (using Hewlett Packard 623B SHF test set);
(6) Receiver threshold sensitivity (using Hewlett Packard 623B SHF test set, Lenkurt 5204 noise loading test set and Hewlett Packard 400L VTVM).

R. A. King, Assistant Superintendent of Communications,
Southern Pacific,
San Francisco, Calif.

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Questions

• To what extent have you standardized on radio sets for certain usages? For example, all mobile units regardless of use are equipped to operate on 64/12 volts DC. Are all base station radios operated on 117 volts AC, or do you provide for 64/12 volt DC base station operation? Do you use rechargeable batteries in your walkie-talkies, regardless of size and RF power? Please describe your practices.

• Do you use switch plate lubricant on non-interlocked power switches? Do you, or under what conditions would you use switch plate lubricant on hand-throw switches? Please describe your methods for applying switch plate lubricant, including mention of the types of lubricants used.

Send answers to these questions to the WA editor, Railway Signaling and Communications, 14 E. Jackson Blvd., Chicago, Ill. 60604. Payment is made for all answers printed. Answers will be printed without names or railroad identification if desired, but all letters with answers must be signed.

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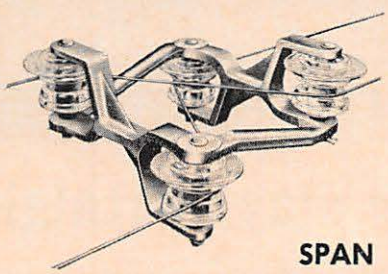

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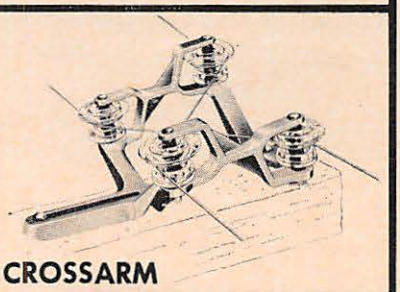

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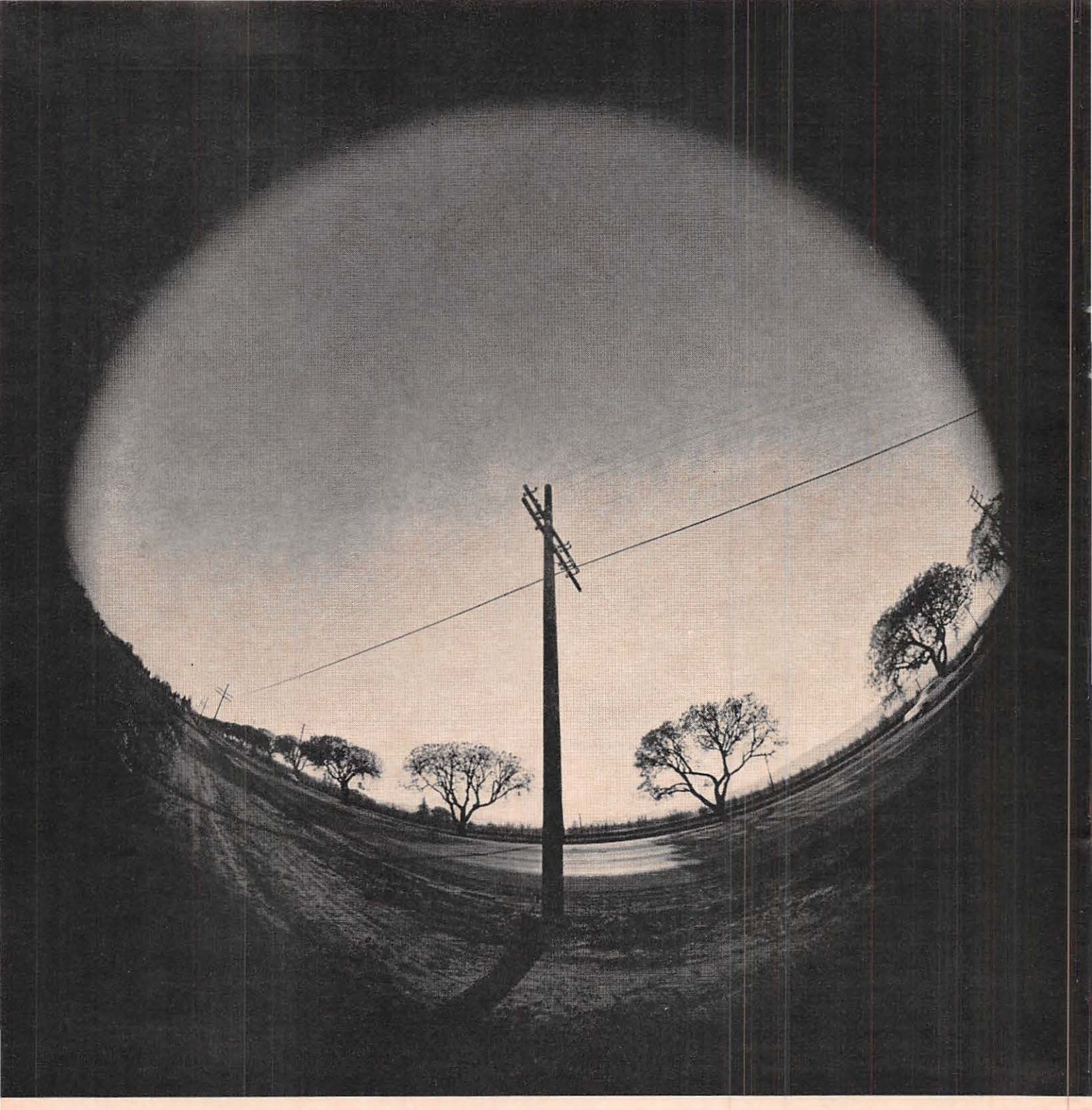

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Nostalgia is probably the most popular game in the world with communications men. Get a couple of guys who have been in the business a long time. You sit around and drink coffee. One of you starts by saying: "Remember when . . .?" You take turns telling about the Good Old Days of open wire.

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Circle 58 on Reader Service Card

PRODUCT NEWS

Monitor Unit

Two new devices to monitor voice quality and signal-to-noise ratios are particularly suited for use in microwave, troposcatter, HF radio, and wire-line systems. In such applications the VF channel (VQM-1) and S/N ratio (SNM-2) monitors permit instantaneous, continous and automatic data reduction for proof-of-performance tests; automatic quality-monitoring of operating systems and correction of faults before the system deteriorates beyond use, quick and easy final checkout of equipment before returning it to service, and automatic, continuous monitoring of priority channels.

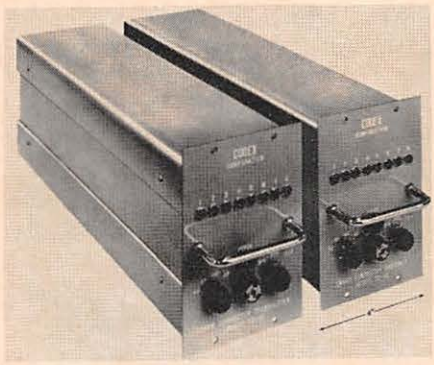
They contain all the circuitry and /or devices needed for monitoring one end of a duplex circuit. Full monitoring of a duplex circuit requires use of two monitor units. Quick, visual operational checks of a number of monitors can be made at a distance by observing the colored panel display lamps, which indicate various signal-to-noise ratio ranges.

Tedious, time-consuming data reduction can be obviated by periodically reading and recording the time indicated on the clocks, which are offered as optional equipment. Each clock records the time that S/N levels range within the limits indicated. S/N ratios may also be recorded by use of standard chart recorders.

Remote auditory indication of faults or degraded channels may be obtained by use of the alarm. It may be switched to activate at any one of the S/N ranges indicated by the front panel lamps.

In design, the SNM-2 and VQM-1 units each consist basically of a tone-generating module, two (tone and noise) modules, an electronic comparing network and a display panel including S/N lamps, direct reading S/N and receive-level deviation meters. Modularized, transistorized plug-in type construction is used throughout.

SNM-2 S/N radio range is from 10 to 60 db and the VQM-1 from 5 to 45 db. Required power supply is 48 volts AC, 1 amp; or 117 volts AC, 100 watts. Ambient temperature range is 0-50°C. The over all dimensions are 7″ high, 19″ wide, and 12″ deep. Approximate weight is 20 lb. *Communications & Electronics Division of Philco Corp. Circle 1 on Reader Service Card.*



Error Detector Unit

A new system, TD-12, is designed to protect standard telegraph message channels, on high-error-rate links in such channels, from the effects of random errors and error bursts introduced during transmission. TD-12 units detect virtually all such errors and correct them automatically as they are received, eliminating the necessity for repeated retransmission to get a clear message. Transmit and receive units are in separate packages, each with its own power supply. A pair constitutes a duplex terminal or a complete simplex system; four units can be mounted in 6″ of rack height. The unit has four basic transmission speeds in either start-stop or syn-

(Please turn to page 44)

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How tone signals can be used in controls

By L. C. Menkes
Vice-President
Quindar Electronics, Inc.

In spite of the development of exotic telemetering and remote control techniques, industry is making wider use than ever of simple tone signaling whose reliability has been proved in railroad telegraph transmission applications and whose cost is considerably lower. Coded tone signals have been used for many years and are being used extensively for remote control, telemetering and data transmission over wire lines, carrier telephone channels, radio links and microwave systems. Intelligence is transmitted by on-off, frequency-shift or phase-shift keying of audio tones. Numerous tones can be transmitted over the same medium by operating each tone channel at a different frequency.

Tone signaling is an adaptation of radiotelegraphy. At radio frequencies the carrier is keyed off and on or shifted in frequency to transmit intelligence in International Morse Code or Teletype Code. Tone signaling employs similar techniques except that the carrier is at an audio frequency and the transmission medium is a pair of wires, a carrier telephone circuit or the intelligence-bearing baseband of a radio link or microwave system.

Tone signaling was first used to permit simultaneous transmission of several telegraph signals over a single pair of wires. Later, it was used in mobile radio systems for selectively signaling mobile units from a base station. In carrier telephone systems, which enable transmission of several telephone conversations over a single pair of wires, tone signaling is employed for transmission of ringing signals and dial pulses on an AC basis.

Tone signaling is now used widely for transmission on control signals and report-back signals in remote supervisory control systems, status signals, digital and analog telemetering signals, and serial or parallel data.

Tone signals can be used to turn electrically-actuated devices on and off, report their status and convey quantitative information over almost any distance, depending upon the characteristics of the transmission medium.

Typical applications include remote control and telemetering of water pumping stations, remote control of closed circuit television camera (pan, tilt, focus, iris, lens-change, etc.), remote control of broadcasting transmitters, remote control of process equipment, etc.

A tone channel consists of a tone transmitter and a tone receiver, both tuned to the same audio frequency. Up to 32 tone channels operating at differing frequencies may be accomodated by a single voice grade circuit, the number depending upon the spacing of the tone frequencies, the selectivity of the tone receivers, the speed at which the tones are keyed and the quality of the transmission medium.

In an on-off (AM) tone transmitter, the tone is keyed on and off by a pair of contacts or a DC voltage. When the tone is present, a relay is energized or a DC output voltage is delivered at the output of the associated tone receiver. In the absence of tone, the relay drops out or the DC output voltage is cut off.

A tone is transmitted at all times by an FM or FSK (frequency shift keyed) tone transmitter. To transmit intelligence, the tone is shifted in frequency (usually upward) by closure of a pair of contacts or application of a DC input voltage. At the associated tone receiver, the change in tone frequency is sensed and the sensing circuit causes a relay to pull in or a DC voltage to appear at the output.

There are two kinds of FSK tone channels, two-state and three-state. In the latter, the tone can be shifted upward and downward, but not simultaneously. The center frequency (neutral) is normally transmitted. To transmit intelligence, the tone is alternately shifted upward and downward (mark and space signals), with the neutral signal never transmitted except during intervals

(Please turn to page 40)

Fig. 1: Standard tone frequencies.

AM and ±25 cps FS	AM and ±30 cps FS	AM and ±32 cps FS	AM and ±42 cps FS
365	420	3625	425
465	540	3775	595
565	660	3925	765
665	780	4075	935
765	900	4225	1105
865	1020	4375	1275
965	1140	4525	1445
1075	1260	4675	1615
1175	1380	4825	1785
1275	1500	4975	1955
1375	1620	5125	2125
1475	1740	5275	2295
1575	1860	5425	2465
1675	1980	5575	2635
1775	2100	5725	2805
1875	2220	5875	2975
2000	2340	6025	3145
2100	2460	6175	3315
2200	2580	6325	3485
2300	2700	6475	3655
2400	2820	6625	3825
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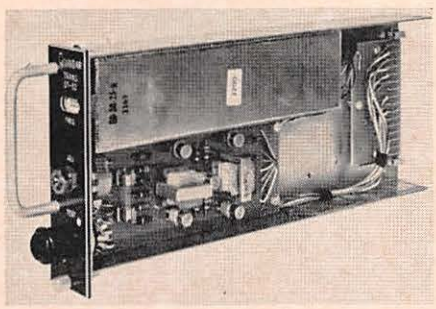

Fig. 3a: Tone transmitter.

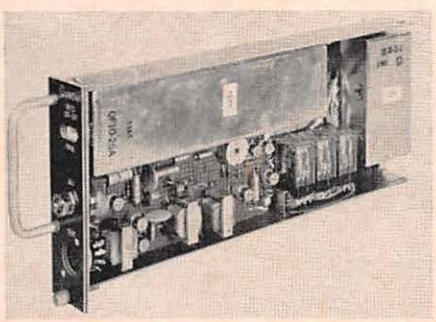

Fig. 3b: Tone receiver.

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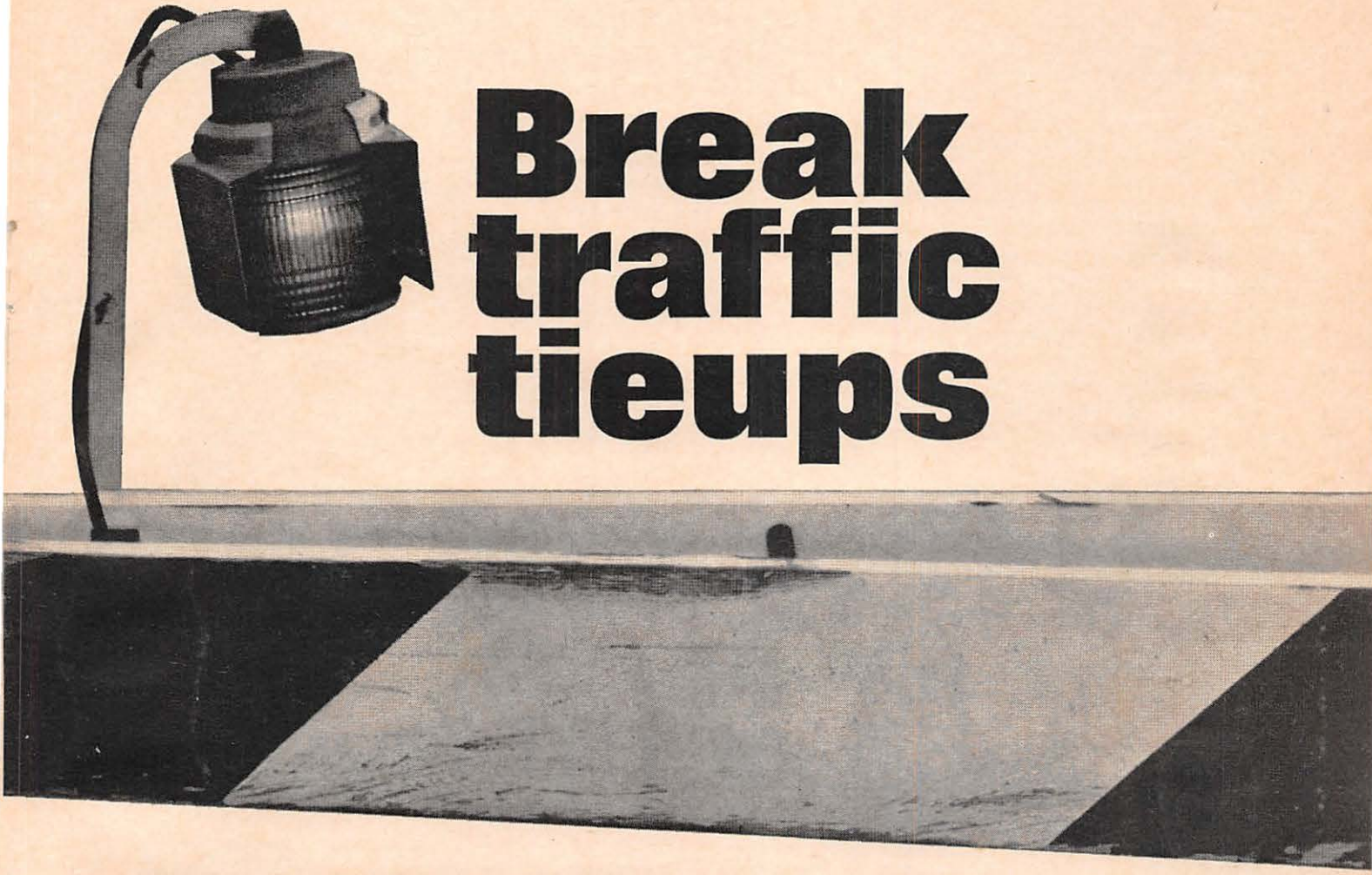

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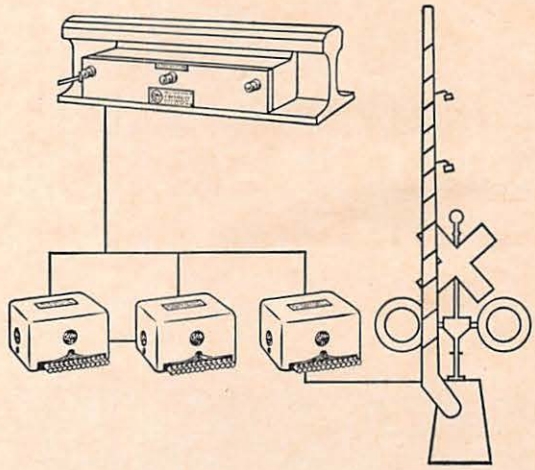

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Circle 68 on reader service card

(Continued from page 36)

between transmissions. Or, the mark and space signals can be used independently, but not at the same time.

In addition to on-off and FSK tone channels, phase shift keying (PSK) of a tone is also used. There are also continuously variable FM tone channels which are used for analog telemetering, principally in aerospace applications where the relatively high cost can be justified. The frequency of the tone transmitter is varied in proportion to the monitored DC voltage. At the receiver, tone frequency is converted into a DC voltage proportional to frequency.

For most applications, however, on-off or FSK tone transmission is used. Most tone systems employ electronic oscillators to generate tones whose frequencies are determined by resonant L-C circuits. Receivers employ electronic amplifiers and demodulators with frequency selection provided by passive L-C filters.

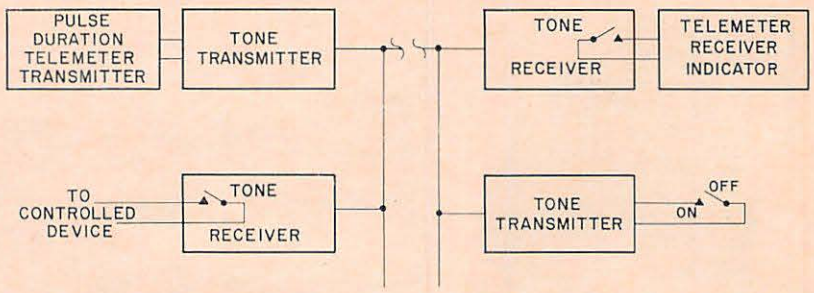
In some low-cost tone systems, resonant reeds are employed to determine transmitter frequencies and vibrating reed relays to provide frequency selection at the receivers. These systems have relatively slow response since it requires 100 milliseconds or more for the resonator to stabilize and even longer for the relay to respond. The vibrating reed type tone systems operate at frequencies below 1,000 cps, whereas the faster-responding L-C types operate at frequencies from around 300 cps to as high as 7 kc. The standard L-C tone frequencies are listed in Figure 1.

The input signal can be a DC voltage or produced by a pair of contacts. The output signal can be a DC voltage or a relay contact closure. An on-off tone receiver has two possible output conditions, a two-state FSK tone receiver has three (mark, space or no tone at all), and a three-state FSK receiver has four (mark, neutral, space or no tone).

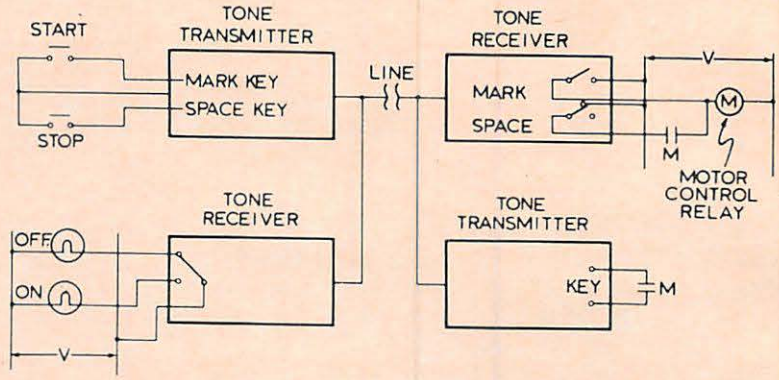
When on-off tone keying is used, the tone can be turned off during intervals between transmissions. Or, the tone may be transmitted continuously and interrupted to denote intelligence. FSK systems are more secure in that absence of tone can denote equipment or circuit failure. Some three-state FSK receivers are equipped with an alarm output which delivers a signal when no tone is present.

The tone receiver output is sometimes used directly but more often

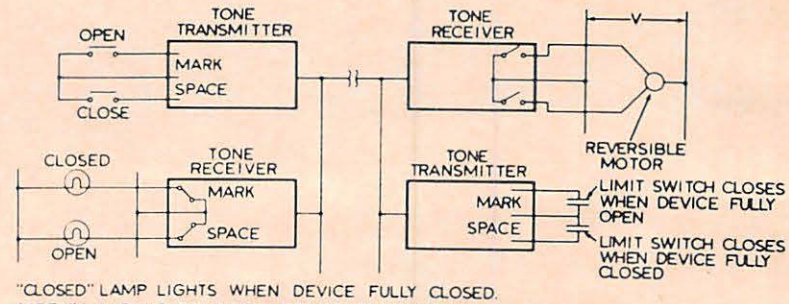
Fig. 2: Typical tone channel applications.



AM (on-off) telemeter and control.



Start-stop control of motor (FSK channel); on-off supervision (AM channel).



"CLOSED" LAMP LIGHTS WHEN DEVICE FULLY CLOSED.
"OPEN" LAMP LIGHTS WHEN DEVICE FULLY OPEN.
BOTH LIGHTS ON FOR INTERMEDIATE (CAN BE ARRANGED FOR NO LIGHTS ON FOR INTERMEDIATE)

Open-close control; open-close intermediate supervision (FSK channel).

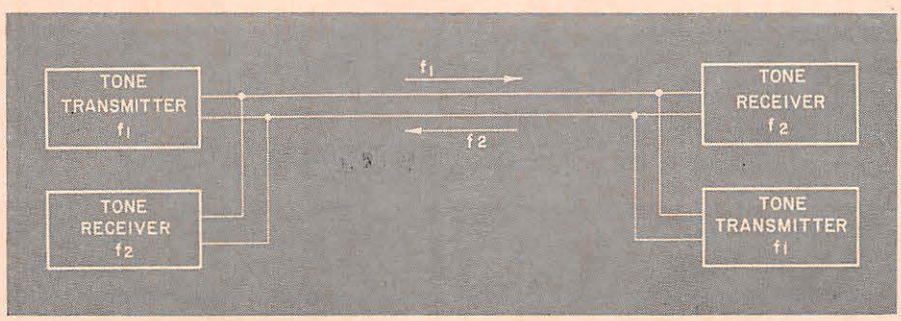


Fig. 4: Wire-line circuit uses different frequencies for each direction.

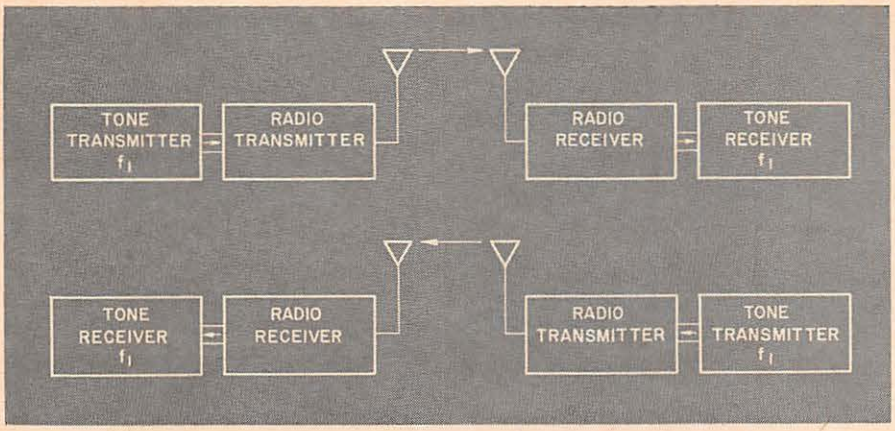


Fig. 5: Tone frequencies may be duplicated on radio circuit.

to drive external relays or logical devices. A single tone (on-off or FSK) can be used to transmit intelligence in serial form. Two or more tone channels can be used to transmit intelligence in serial or parallel form. For example, logic can be used to control a function when tones A, B and C are transmitted in a predetermined sequence, or when transmitted simultaneously. A relay tree can be used, for instance, to enable control of up to 31 functions using only 5 tone channels. A single tone channel can be used to transmit any of millions of different control signals, one at a time, by pulsing the tone with a telephone dial. Typical applications of AM (on-off), AM/FSK and FSK tone channels are illustrated in Figure 2. *(See box on opposite page.)*

Quantitative analog information can be transmitted over an on-off or FSK tone channel by keying the tone transmitter with a pulse duration telemeter transmitter and using a tone pulse to drive a telemeter receiver. Digital information, of course, can be transmitted by pulsing tones to produce "0" and "1" signals.

While tubes were widely used in the past, modern tone transmitters and receivers are solid state devices except for output relays whose use is optional. Tone transmitters and receivers are usually packaged as individual plug-in modules, as shown in Figure 3. The modules plug into a mounting frame which also accommodates a power supply capable of handling several transmitters and receivers. Individual tone transmitters and receivers are also available which can be used separately.

A pair of wires, of course, is bi-directional and can be used for transmission of tones in either direction as shown in Figure 4. When a four-wire circuit or duplex radio link, microwave system, or carrier telephone channel is used, the tone channel capacity is doubled since the tone frequencies can be duplicated as shown in Figure 5.

A single tone channel is often used to control or monitor a number of two-state conditions. A typical example is shown in Figure 6. An

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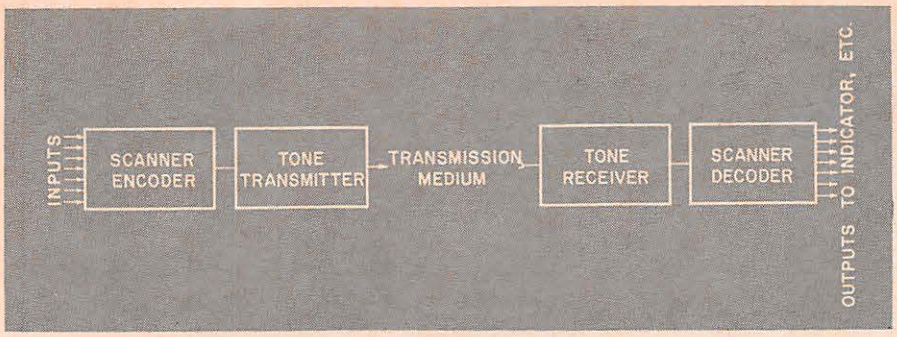


Fig. 6: Single tone channel controls or monitors several two-stage conditions.

electronic scan encoder looks at a number of contacts sequentially and keys an FSK tone transmitter which transmits mark or space tone signals to denote whether the monitored contacts are open or closed. At the other end of the circuit, a tone receiver translates the tone signals into DC pulses which drive an electronic scan decoder in synchronism with the scan encoder. The status of each set of contacts is displayed by lights and/or the signals may be used to control other devices.

Ordinarily, commercially available tone transmitters and receivers are designed for use over a 600-ohm transmission medium such as a voice grade telephone circuit, whether a physical pair or a carrier telephone channel. The equipment is so designed that the loading is approximately 600 ohms at the channel frequency, considerably higher at other frequencies, thus permitting connection of numerous channels without excessive loading of the transmission medium.

Tone signals can also be transmitted over other kinds of wire circuits as may be installed in buildings for intra-plant service. When necessary, impedance matching devices can be installed to minimize losses on relatively long circuits. Coaxial cable is sometimes used for transmission of video signals in closed circuit TV systems along with tone signals for remote control of cameras and lighting. The tones can be applied directly to the coax if the video signals are transmitted over a subcarrier, or when the video signals go down to DC, the tones can be transmitted over a subcarrier at a frequency above the video.

Tone signals are often applied directly to the baseband of microwave systems and other radio links when the voice channels and other intelligence are transmitted at frequencies above 4 kc. In multi-channel radio systems, a very large number of tones can be transmitted by feeding them in groups over several voice carrier channels. In narrow band radio systems, such as HF radio links, the number of tone channels that can be transmitted via the baseband is limited by the system distortion and bandwidth.

The recent allocation of frequencies in the 952-960 mc and 2150-2160 mc band for omnidirectional and directional transmission of control and alarm signals presents interesting possibilities. While the railroad radio channels in the VHF band are normally available for voice transmission only, there are a number of channels in the 25-50 mc, 150-174 mc and 450-470 mc bands, available under Business Radio Service licenses to railroads, on which tone signals can be transmitted point-to-point. The FCC can authorize transmission of other than voice. These channels are the so-called low power channels on which power input is limited to three watts. However, gain type antennas can be used to increase effective radiated power. All transmitters, even those at fixed locations, are classed as mobile units.

When a narrow band radio transmission system is used, a number of local DC circuits can be terminated at a marshalling point, as shown in Figure 7, where they are scanned. The scan encoder then keys a tone transmitter whose signal is transmitted over the radio link. At the radio receiver, the tone is converted into DC pulses and used to drive a scan decoder.

Another transmission medium that is regaining attention is the G-line which is capable of handling

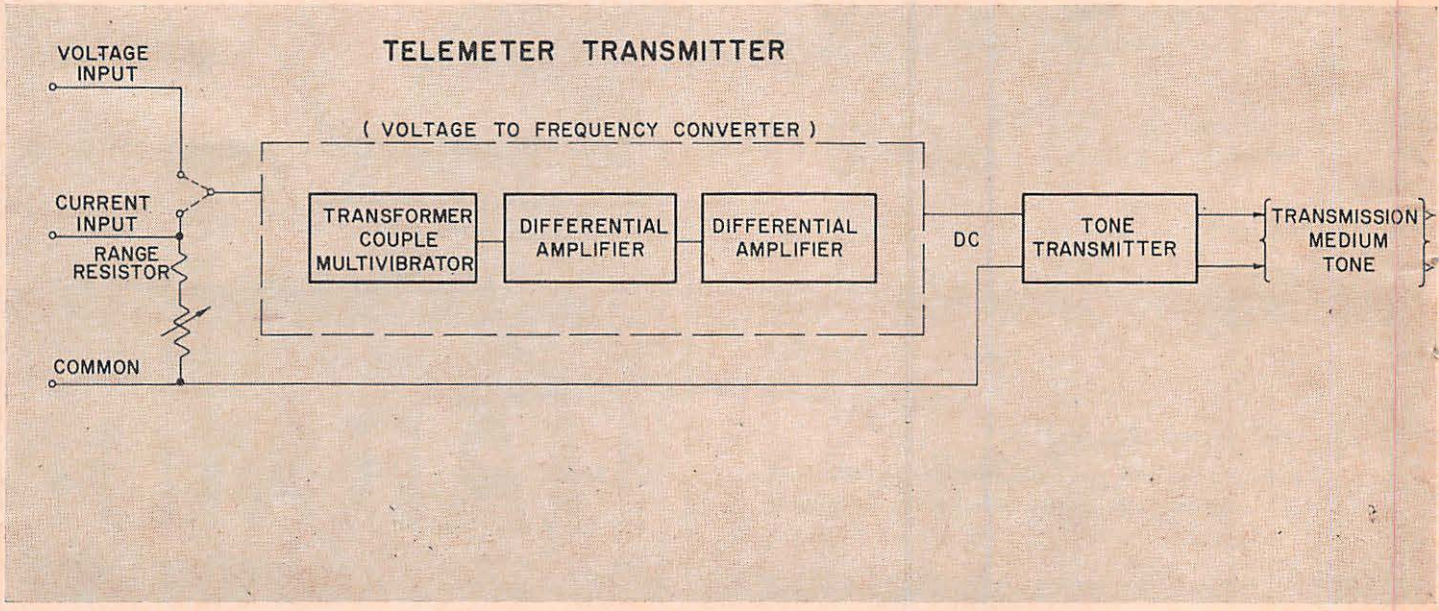


Fig. 8: Quindar QATS-10 system is for analog telemetering. The transmitter delivers an output signal consisting of a continuous

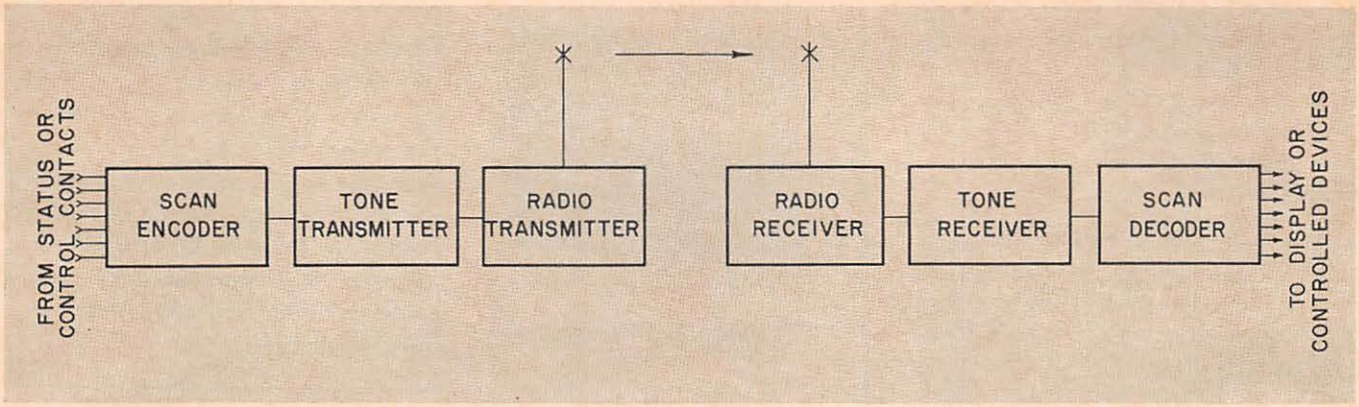


Fig. 7: Many local DC circuits can be ended at a collection point when sent via narrow band radio transmission.

several broad band radio channels simultaneously. External radiation is very small and attenuation is much lower than for conventional coaxial cable. Tone signals can be transmitted over a radio carrier applied to the G-line and picked off with a radio receiver without having to make physical contact with the G-line. While originally in tended for outdoor use, the G-line may find applications indoors for conveying several closed circuit television channels on an RF basis and carrier telephone circuits via RF channels as well as high speed data along with tone signals for remote control and telemetering.

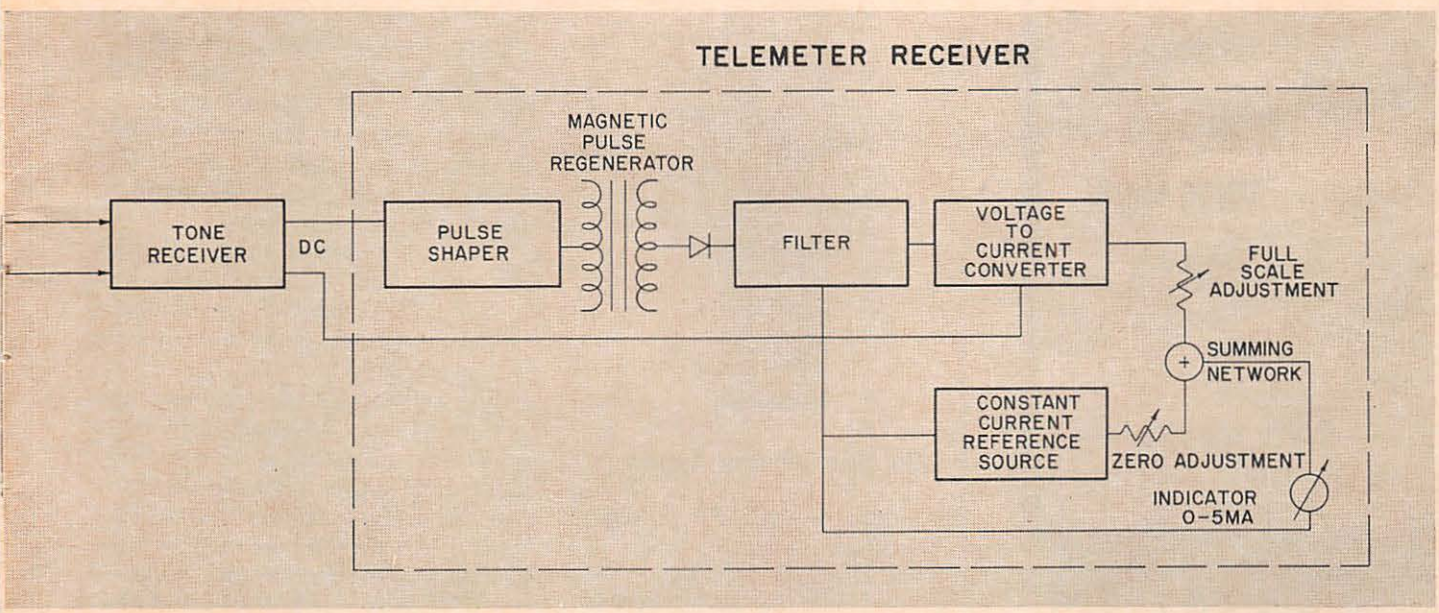
As mentioned earlier, analog FM tone transmitters and receivers are widely used in aerospace instrumentation systems with tone frequencies as high as 70 kc. Recently, however, analog tone channels have become available which operate at much lower carrier frequencies, within the voice range. This makes it possible to convert DC voltage into frequency and back into voltage at the receiving end of the circuit for low cost analog telemetering. The same kind of circuit can also be used for analog control using a potentiometer or other device at the transmitting end of the circuit to control a voltage sensitive device at the other end of the circuit.

A recent development in analog telemetering is the Quindar QATS-10 system. It employs a telemeter transmitter consisting of a voltage-to-frequency converter, which can be used with either current or voltage input. The telemeter transmitter delivers an output signal consisting of a continuous train of pulses whose frequency ranges from 5 cps to 25 cps in proportion to the DC input signal.

The DC output pulses can be fed directly to the associated telemeter receiver or to a tone channel which converts the DC pulses into tone pulses, and then back into DC pulses, as shown in Figure 8. The telemeter receiver employs a pulse reshaper, pulse regenerator and a voltage-to-current converter. Depending upon the frequency of the pulses, the output current ranges from 0-5 ma.

Voltage-to-frequency conversion linearity, in terms of maximum deviation as a percentage of full scale is better than 0.2%. Frequency-to-current conversion linearity is also better than 0.2%.

While there are various, more exotic and telemetering schemes in use, particularly in the aerospace field where fast response is necessary, the pulsed tone techniques described here are more than adequate for most industrial applications. The field's in which lower-cost tone signaling can be applied successfully are expanding as systems engineers discover its capabilities. **RS&C**



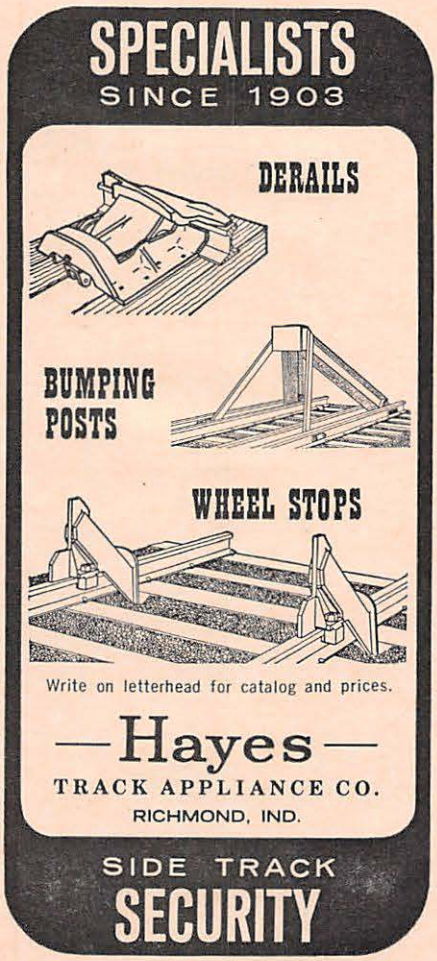
train of pulses whose frequency ranges from 5 to 25 cps in proportion to the DC input signal.

(Continued from page 35)

chronous modes. It is fully compatible with standard VF telegraph equipment. *Codex Corp. Circle 2 on Readers Service Card.*

• MULTIPLEX SYSTEM: Bulletin 46A-P4 describes the 46A multiplex system, which provides multi-channel service for a wide variety of applications—from small light-route systems requiring as few as four voice-frequency channels to large high-density systems requiring as many as 600 channels. It includes complete performance information, equipment description, block diagrams, and photographs. *Lenkurt Electric Co., Inc. Circle 3 on Reader Service Card.*

• ELECTRONICS: A 544-page catalog (#660) lists over 60,000 electronics components, communication gear, sound and allied equipment produced by more than 600 manufacturers. Engineering data and prices are included. *Allied Electronics Corp. Circle 4 on Reader Service Card.*



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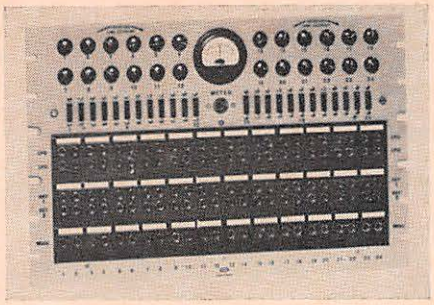
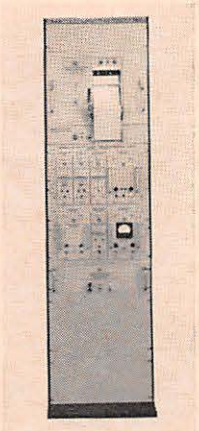


Teletypewriter Monitoring Unit

Model SB-2405 is a relay-rack mounting, 24 circuit teletypewriter patching and monitoring device housed in a ferrous shielded enclosure. It provides a jack field, loop current rheostats, loop current fuses with internal bell alarm, and meter facilities. Strapping options are provided for 60 ma or 20 ma circuits. The front panel is hinged for service access. Model SB-2405 provides DC teletypewriter loop facilities in a vertical height of 12 7/16". Options which are available include tip, ring, and sleeve jacks, solid state polar/neutral internal relays, and internal local battery power supply. *Orbit Industries, Inc. Circle 5 on Reader Service Card.*

• MICROWAVE SYSTEM: A new brochure describes the 71F microwave radio system, designed for use on lower density routes includes complete performance information, equipment description, block diagrams and photographs. *Lenkurt Electric. Circle 6 on Reader Service Card.*



Hot Box Detector System

The new model 7707 Servosafe hot box detective system offers new improved features developed from experience with the model 7621 system.

"Position open for Assistant Communications Engineer. Prefer young college graduate with electronic-electrical background. Salary commensurate with applicant's training and experience. **Address replies to Assistant Chief Engineer, Signals & Communications, Soo Line Railroad, Box 530, Minneapolis, Minnesota 55440."**

The data control unit has been completely redesigned as an all-relay module. Vacuum tubes and relays have been replaced with long-life, high reliability, mercury-wetted contact relays having fast responsive features.

A shortened gate period (transducer spacing shortened to 28" instead of 38") is made possible by faster relays and permits closer tolerances on bracketing the journals.

Another function of the new data control unit is effecting what shall be called "gated feedback". The same circuits used for gating are used to control the pulse processor gain in such a manner as to allow full gain (determined by the gain control setting) of the amplifier while a journal pip is being recorded; reducing the gain by a large amount between journals. Thus, hot sources in the near vicinity of the journal, which are undesired, are suppressed to a large degree. This feature is designed to reduce materially false indications from extraneous sources, thus improving performance on passenger trains.

Pulse processors have been redesigned to include circuitry providing faster recovery of the amplifier following a large amplitude signal. The gated feedback acts on these amplifiers to produce this effect.

The main power supply is all solid state with built-in short circuit protection. The model 7707 reference voltage standard has been completely transistorized.

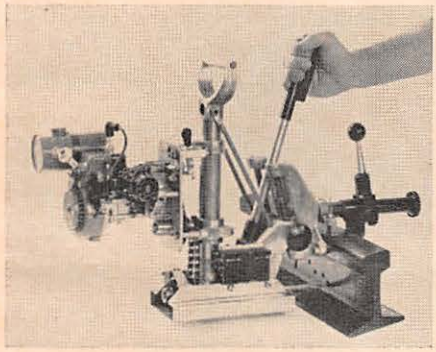
The utility of the system is improved with the addition of the high deflection indicator. It activates an alarm light on the recorder on absolute magnitude and is adjustable from 10 to 20 mm recorder deflection. High heat signals from the journal box on one or both sides of the axle will activate the alarm and draw

the attention of the operator or dispatcher to the recorder tape should he be busy with other duties while the train is passing the scanners. Lights are reset from the recorder front panel.

A compact and rugged 12-volt DC power supply is provided as a replacement for the 12-volt storage batteries.

Some components of model 7621 may be replaced by model 7707 components with very little or no modifications. These are: data control unit, main power supply, and pulse processors. *Servo Corp. of America. Circle 7 on Reader Service Card*

• MULTIPLEX: The prewired four-channel 711 multiplex system, featuring all wiring brought to a terminal block for ease in installation, is described in a new brochure. *Stromberg-Carlson Corp. Circle 8 on Reader Service Card.*



Rail Bonding Drill

The power-operated, light weight and high speed P650 rail bonding drill, equipped with a one horsepower gasoline engine, is designed for easy portability by maintenance forces in their routine maintenance and renewal work. Equipment includes set-screw or collet chuck for a ⅜" or 9/32" bonding bit. The unit weighs 25 lb. *Railroad Accessories Corp. Circle 9 on Reader Service Card.*

• CONTROL SYSTEMS: A new brochure illustrates three control systems product categories: Locotrol, a system for precise control of railroad locomotive consists; supervisory control systems, for pipe line, utility, and industrial applications; and direct digital control systems, for industrial processes. *Radiation Inc. Circle 10 on Reader Service Card.*

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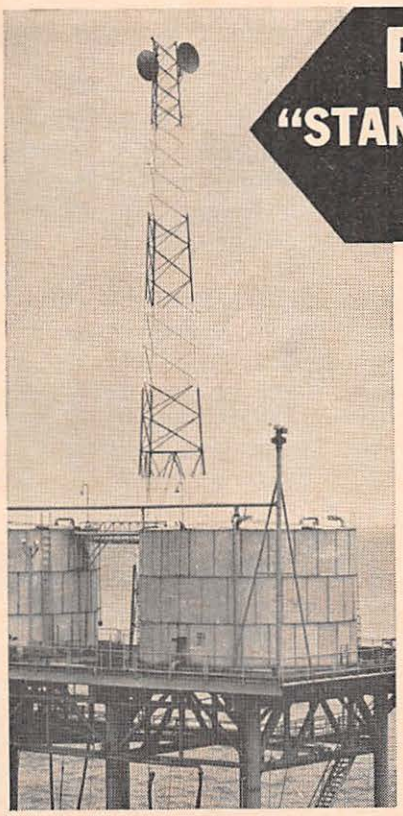

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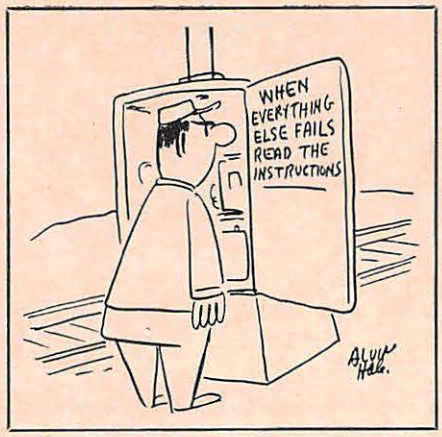
(Continued from page 10)

succeeding **J. R. White,** retired. **Malcolm L. Prentice,** regional manager of western Canada, appointed assistant general manager, there.

Mr. Clarke was born in Victoria, Nfld. He attended the Methodist college and Memorial University in St. John's, Nfld., before graduating from Dalhousie University, Halifax, N.S. with a BS degree in 1932. Two years later he joined the Newfoundland department of posts and telegraphs as an inspector in the telegraph division. In 1945 he was appointed assistant secretary of the department following his military service with the Royal Canadian Corps of Signals. Four years later, when the CNT took over the telegraph division of the provincial department, he was appointed CNT's Newfoundland superintendent. In 1955, Mr. Clarke was appointed general superintendent of CNT's western region with headquarters at Winnipeg, Man. Four years later he was appointed assistant general manager of telecommunications at Toronto, Ont., the position he held during his recent appointment.

Mr. Prentice joined CNT as a technical assistant at Toronto, Ont. in 1928 and subsequently was promoted to various positions in radio and communications. In 1951 he was appointed superintendent of operations at Montreal, Que. Four years later he was appointed superintendent at Toronto, Ont. In 1959, he was assigned to a post which was later moved to Edmonton, Alta. and was named regional manager of western Canada, the position he held prior to his recent appointment.

Mr. White was born in Ottawa, Ont., December 8, 1900. After attending the University of Toronto, Ont. in 1923, he joined the Canadian



National operating department at Battle Creek, Mich. A year later he was assigned to the Bureau of Economics, at Montreal, Que. and in 1929 to the Bureau of Railway Economics at Washington, D.C. Two years later he was appointed assistant to the vice-president in charge of subsidiary companies. In 1923, Mr. White was made supervisor in charge of budgets; chief of tariffs, commercial manager and chief of commercial operations. In 1951, he was appointed general manager of telecommunications at Toronto, Ont., the position he held at the time of his retirement.

• SANTA FE: **Taylor S. Steward,** has been appointed assistant engineer of communications, at Topeka, Kan.

• SEABOARD AIR LINE: **Alfred V. Wilson,** construction supervisor, appointed supervisor telephones and signals at Tampa, Fla., succeeding **Ralph Dunham,** retired.

• WESTERN PACIFIC: **Bruce L. McNeil, Jr.,** signal engineer, appointed engineer signals and communications at Sacramento, Calif. **Norman W. Menzies,** superintendent of communications has retired. **Robert E. Enger,** communications engineer, appointed superintendent of communications at San Francisco, Calif., succeeding Mr. Menzies. **Earl A. Thompson,** assistant to signal engineer, appointed assistant to engineer signal and communications at Sacramento, Calif., Signal and communications headquarters is now located at 1025 19th St., Sacramento, Calif.

Supply Trade News

• GENERAL RAILWAY SIGNAL CO.: **R. H. Schmuck,** assistant western manager at Chicago, has been transferred to New York as assistant eastern manager. **Robert K. Wickliffe,** assistant eastern manager, is transferred to Chicago as assistant western manager, succeeding Mr. Schmuck.

• LENKURT ELECTRIC CO., INC.: **Donald E. Stacy,** senior sales engineer, appointed field service manager at San Carlos, Calif. **John H. Beeger,** eastern district sales engineer, will assume the telephone sales district position formerly held by Mr. Stacy.

• THE MID-CONTROL CO.: **Richard G. Sass,** has been named vice-president in charge of railroad sales at Chicago, Ill.

• SIMPLEX WIRE & CABLE CO.: **Thomas A. Prentiss,** vice-president, has been appointed general manager of the power and control division. **Dennis R. Don,** has been promoted to manager of marketing of the power and control division.

• MARQUARDT CORP.: **G. K. Adams** has been appointed midwest regional manager with headquarters in Chicago. Mr. Adams was formerly district manager at New York for Union Switch & Signal division of WABCO.

Harold J. Clarke
Can. Nat. Tel.

J. R. White
Can. Nat. Tel.

Malcolm L. Prentice
Can. Nat. Tel.

Donald E. Stacy
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John H. Beeger
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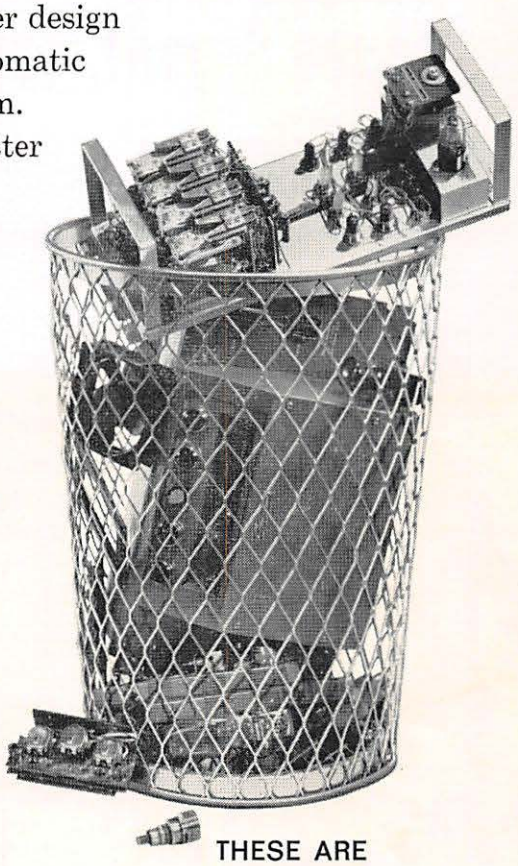

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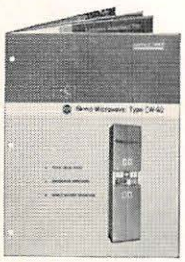

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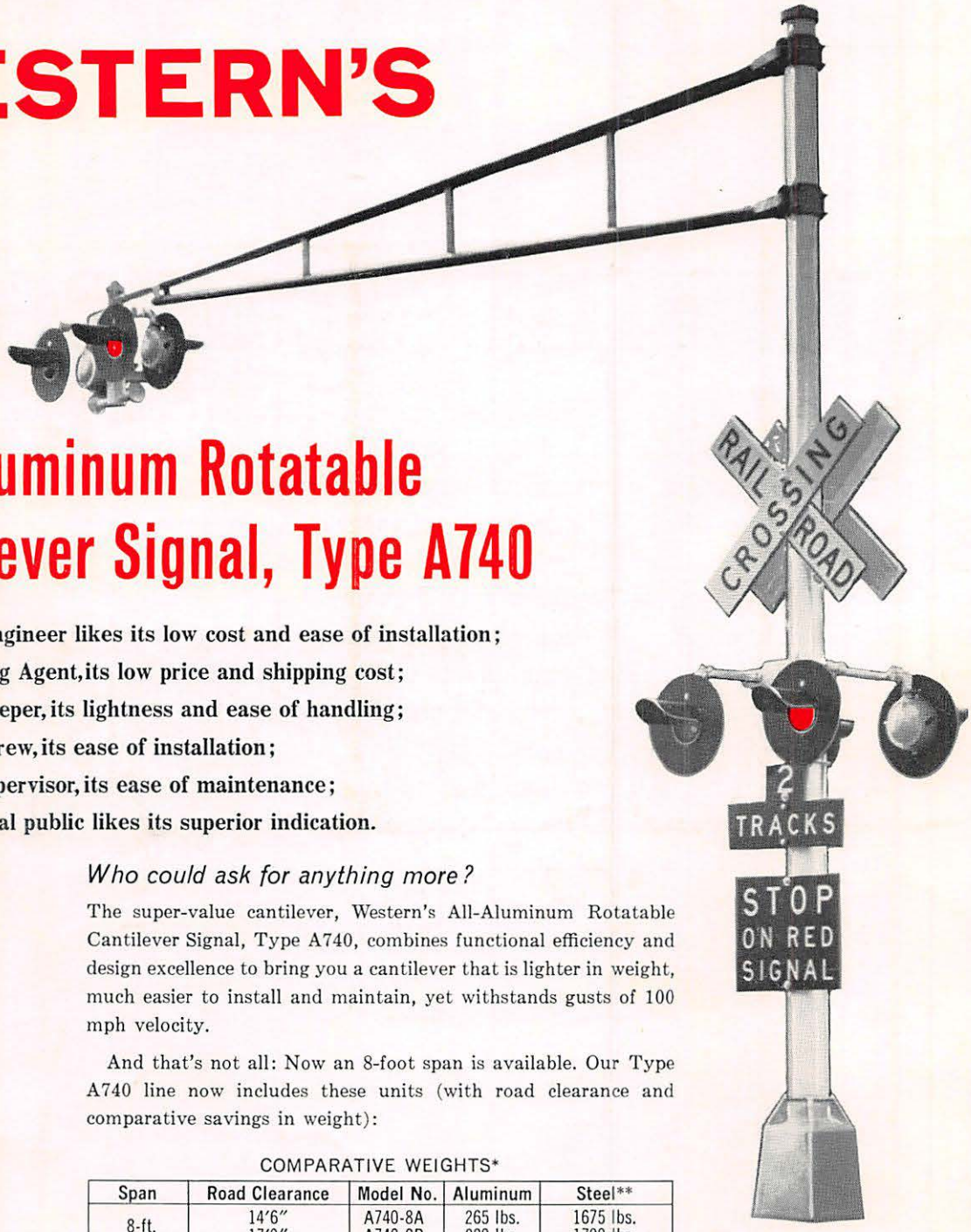

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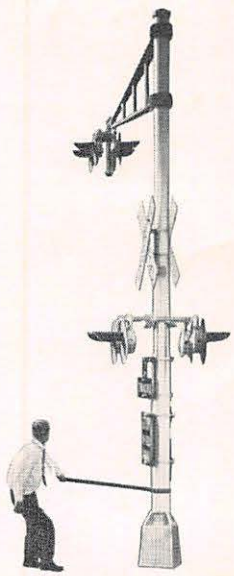
The super-value cantilever, Western's All-Aluminum Rotatable Cantilever Signal, Type A740, combines functional efficiency and design excellence to bring you a cantilever that is lighter in weight, much easier to install and maintain, yet withstands gusts of 100 mph velocity.

And that's not all: Now an 8-foot span is available. Our Type A740 line now includes these units (with road clearance and comparative savings in weight):



COMPARATIVE WEIGHTS*

Span	Road Clearance	Model No.	Aluminum	Steel**
8-ft.	14'6" 17'0"	A740-8A A740-8B	265 lbs. 280 lbs.	1675 lbs. 1700 lbs.
12-ft.	14'6" 17'0"	A740-12A A740-12B	290 lbs. 305 lbs.	2210 lbs. 2250 lbs.
15-ft.	14'6" 17'0"	A740-15A A740-15B	310 lbs. 325 lbs.	2315 lbs. 2380 lbs.
20-ft.	14'6" 17'0"	A740-20A A740-20B	390 lbs. 410 lbs.	Not Furnished Not Furnished

* Approximate for structure only. ** Fixed span.

Would you like drawings and detailed information? . . . Please contact us:

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Circle 69 on reader service card

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